MAY 6 1911

SCIENTIFIC AMERICAN SUPPLEMENT. No. 1844

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1910, by Munn & Co., Inc.
Published weekly by Munn & Co., Inc., at 361 Broadway, New York.
Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXXI., No. 1844. { NEW YORK, MAY 6, 1911 } **Scientific American Supplement, $5 a year.**
Scientific American and Supplement, $7 a year.

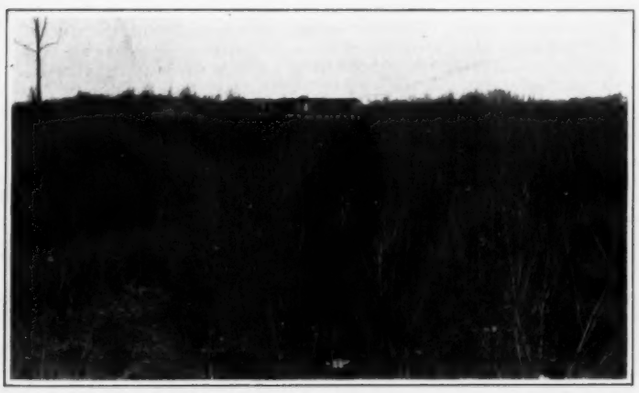
An Artificial Method of Forcing Basket Willows

BASKET willow growers can not always find a good market for steam peeled rods, and are therefore obliged to peel them in sap. To do so requires considerable work during the spring months when other work on the farm is plentiful and labor is scarce. If a grower has a large willow plantation and wishes to peel his rods in sap he is obliged to employ an unusually large force and pay them higher wages than they could get elsewhere, in order to complete the work by the first of June. Or he may erect a forcing house, hire fewer men, pay less wages, commence to peel about the first of January, which will give him plenty of time to complete the job before the other work on the farm begins.

Messrs. Lohrig & Odenwald, of Baltimore, Maryland, erected a building in which their willow rods are forced to sprout during the winter months, at a time when they are peeled in sap. The main buildings are located at Laurel, Maryland, where the firm owns a 60-acre plantation. The largest building is about 100 feet long, 40 feet wide, and 2 stories high. The location of the plant is excellent, being close to the station of the Pennsylvania Railroad, where the peeled rods can be placed on board the cars and shipped to their basket and furniture factories in Baltimore. The owners who have been experimenting for nearly eight years have finally demonstrated that this method of treating basket willow rods is an entire success. They are able to harvest and to peel their entire crop by the end of March, which is the time when other willow growers commence to cut their rods. The operation has been actively going on with about 40 hands since the first of January. "We have the only plant of its kind in America and save a good deal of time and money," Mr. Lohrig said. "One of the greatest advantages of this artificial method over that of the natural method of preparing the rods for peeling is the fact that the work can be done during the winter months when labor is cheap and plentiful."

Ordinarily willows are harvested in March, tied in bundles about a foot in diameter and set butt end down in running water about 4 or 6 inches deep. They are left in this position until the sap commences to flow, when they are ready for peeling. This usually lasts from April 15th to about the first of June. Instead, however, of having only a month or six weeks at most in which to do this work, Mr. Lohrig has over five months' time. To erect a suitable building and to equip it for work is expensive, but the farmer who has 10 acres or more of willows would find it profitable to put up a forcing house. The building should be so constructed that every square foot may be utilized to the best advantage. The best results can be attained only if the conditions within the plant are as favorable as those during the best growing conditions outside. The thing of first importance is the maximum amount of light and heat from the sun, and second, the proper forcing bed, or pit, which should consist of rich, fertile soil about 6 inches deep underlaid with an impermeable concrete floor. The soil must be kept thoroughly saturated with water. The pit must be supplied with water at one end with a run-off at the other, so that the soil cannot turn sour or the water become stagnant.

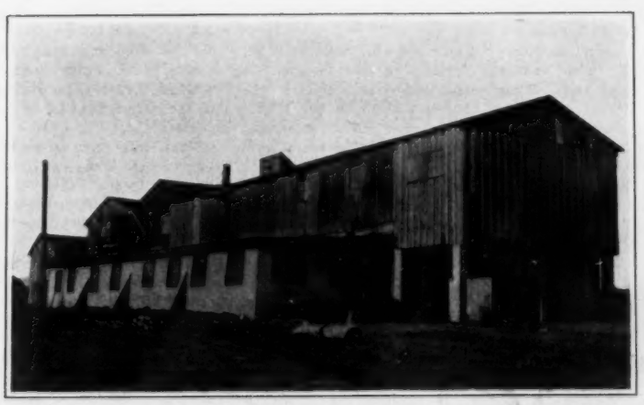
WILLOW RODS BUNDLED AND READY TO BE PLACED INTO THE PIT TO SPROUT



A PORTION OF THE PLANTATION SHOWING THE FORCING HOUSE IN THE BACKGROUND

PEELED RODS IN THE DRYING ROOM

PEELING ROOM, WHERE THE BARK IS REMOVED FROM THE RODS BY DRAWING THEM BETWEEN TWO STEEL PRONGS



THE FORCING HOUSE IN WHICH THE WILLOW RODS ARE SUBJECTED TO ARTIFICIAL HEAT, CAUSING THEM TO SPROUT, AFTER WHICH THE BARK IS REMOVED

AN ARTIFICIAL METHOD OF FORCING BASKET WILLOWS.

The forcing room in the building here illustrated faces south with a view to derive as much light and heat from the sun as possible, and to protect it against the cold north winds. To the north of the forcing room is the peeling room, and to the west the boiler room. The drying room is immediately above the boiler room. A building of this kind is kept as low as possible for the purpose of saving in heat. The peeling room, however, is as high or higher than any ordinary working room. In Germany the forcing houses are provided with glass roofs, which are considered a great improvement over the kind here shown. A glass roof slightly slanting would undoubtedly add to the success of the plant, especially if provisions were made to cover it with a poor conductor of heat during the coldest nights of the season, to prevent chilling the sensitive young shoots. The specifications for a building of this kind are determined by the amount of willows to be treated, as well as by the local conditions and conveniences at hand. The steam required to heat the plant may be drawn from the exhaust pipes of breweries, creameries, or grist mills, and under such conditions, the building and equipment would naturally take on a shape and arrangement according to conditions.

An attempt will be made here to give a few facts helpful in planning a forcing house and equipping it properly. The forcing room is the most important one, and the size of the other rooms is dependent upon this one. Since the basket willow plant by nature requires at least six weeks of rest, it is useless to place the rods into the forcing room before December 15th, and it is better not to do so until after the first of January. One must not count on more than four months to accomplish this, for the willows commence to sprout in the open as early as April, when there will be no need of subjecting them any longer to artificial heat.

One bundle of willows a foot in diameter requires a square foot of standing room and must remain in this position for at least two weeks before the rods are ready for peeling. Two bundles can be forced each month on one square foot, and during four months, from the first of January to the end of April, it will be possible to sprout eight bundles. It is best to select only the short and medium grade rods to be treated in this way, because the long rods sprout much quicker in the open, and labor can be secured more readily during the spring for peeling long rods than for the short ones. The small rods require more care in peeling so as not to split them, and there is more time during the winter to take caution in this respect than during the busy season in spring. Less room is also required for peeling the short rods than for the longer ones, which may be peeled in the open during the spring months.

One bundle of short and middle sized rods weigh approximately 33 pounds, and during four months it will be possible to sprout about 264 pounds of green rods, which will yield about 66 pounds of dried sap peeled willows. About 75 per cent of the original weight is lost in peeling and drying. In one day of 10 hours a man can peel about 100 pounds of green rods, which amount to about 25 pounds of peeled rods after they are thoroughly dried. At this rate it will take one man 24 days to prepare 600 pounds for market. In 120 working days—the length of the peeling season—he can peel 3,000 pounds, which, in the form of green rods, would require a space of 45 square feet in the forcing room. Three thousand pounds of dry peeled rods is an average yield one can expect from an acre of willows. Since one acre requires 45 square feet in the forcing room, a 10-acre plantation calls for a pit 9 by 50 feet, or 450 square feet.

The space required by one man in the peeling room is about 40 square feet, which has been found to be the best under all practical conditions. If one wishes to save in space required for peeling he can do so by having a night force at work, when only half the space is needed. The boiler room must be large enough for a boiler with a 150-gallon capacity and the necessary room around the boiler for the storage of coal and wood. A room 10 by 14 feet will be large enough for a boiler of the above named capacity. The drying room must be about 6 feet wide, 10 feet long, and about 7 feet high to dry the rods of a 10-acre plantation. This room must have a rack 6 feet wide, 10 feet long and 7 feet high, which will be large enough to hold all the willows 10 or 15 men can peel in a day.

Charles Darwin—II*

The Justification of the Darwinian Theory

By August Weismann

Continued from Supplement No. 1843, page 267

In all his descriptions of what he saw his keen appreciation of the beauty and grandeur of nature are manifest. Thus he writes from Bahia on the first day of his arrival in South America: "The day has passed delightfully. Delight itself, however, is a weak term to express the feelings of a naturalist who for the first time has wandered by himself in a Brazilian forest. The elegance of the grasses, the novelty of the parastical plants, the beauty of the flowers, the glossy green of the foliage, but above all the general luxuriance of the vegetation, filled me with admiration. A most paradoxical mixture of sound and silence pervades the shady parts of the wood. The noise from the insects is so loud that it may be heard even in a vessel anchored several hundred yards from the shore; yet within the recesses of the forest a universal silence appears to reign. To a person fond of natural history such a day as this brings with it a deeper pleasure than he can ever hope to experience again" (p. 4, 1884 ed.).

Not less delightful are his descripticns of the monotonous and almost endless plains of Patagonia and the La Plata River, over which, accompanied by Gaucho Indians, he rode for many days; or his account of the wild mountain scenery of Tierra del Fuego, with its gloomy evergreen woods, broken into by deep inlets and bays in which whales disported themselves, and its mountains whcse dark cloud-laden summits are swept by the most violent storms. A different picture is called up by Darwin's description of his ascent from the "Vale of Paradise" (Valparaiso) up the Cordilleras to a height of 13,000 feet, and the view from there down upon the coast region and the Pacific Ocean far beneath him. And how many other passages might be cited!

He cared, however, not only for what was beautiful, but for what was most interesting from a scientific point of view. Thus he discovered in a pass in the Cordilleras a stratum of fossil shells, a proof that this place was at one time a part of the sea floor, and that therefore it had been raised in the corrse of ages more than 13,000 feet.

His journal contains a wealth of observations about plants and animals as well as about man and many detailed accounts of the geological structure of the countries visited. We see how well his Cambridge studies and the excursions he made there had prepared him for this work.

I cannot enter into any details of his observations, but I must at leaae mention those which deal with the facts that led him gradually to change his previous views in regard to the nature and origin of species.

When he first began his explorations in South America he was, as he expressly says, still completely under the influence of the dogma of the creation of species once for all, and their immutability, and he regarded it as unassailable. But very soon he was struck by certain facts which seemed to him difficult to reconcile with this dogma, and these increased in number in the course of his journey, till finally they led him to the conviction that the old position was untenable, and that the organic world had not been created immutable, but had slowly evolved.

I select two of these phenomena, first, the occurrence of the fossil remains of gigantic mammals in the diluvial strata of the great plains of La Plata and Patagonia. Darwin found a gigantic armadillo (*Dasypus gigas*), and he was led to ask how it happened that small armadillos now live in South America, whereas they do not occur, either living or fossil, anywhere else in the world. The answer was easy, if it was possible to assume that the present-day species were descended from the diluvial forms, or from other smaller, still undiscovered forms from the same period. But he was especially impressed by the fauna and flora of the Galapagos Islands, which lie under the equator, 500 nautical miles to the west of the South American coast.

On these isolated and comparatively barren volcanic islands there live many animals which could not fail to arrest the attention of the naturalist—land birds which are like those of the neighboring continent, and those of purely American type, yet are not identical, but closely related species. Most of them are so-called "endemic" species, that is, species which occur in no other part of the world. This was striking enough, but the matter proved even more remarkable on closer investigation, for several of the fifteen islands of which the archipelago consists possess species of the same genus peculiar to themselves—mocking thrushes, for instance, which are represented in the other islands by similar but not identical species.

What inference is possible from these facts except that, at some earlier period, bird migrants from the neighboring continent had landed on these volcanic islands, and in the course of thousands of years had varied, that is to say, had become distinct species on each island?

These and other phenomena aroused in Darwin's mind the idea of evolution, and he resolved to devote his attention to this problem after he returned home, for he was persuaded that he could attain to certainty in regard to it by patiently collecting facts. Thus he set himself the task of his life. It may be well to inquire here whether, or to what extent, Darwin had taken over the idea of evolution from his predecessors at the beginning of the century, and especially from his grandfather, Erasmus. It is certain that at sixteen he had read the "Zoonomia," and that he admired it. He relates in his autobiography that, during his student days in Edinburgh, Dr. Grant, afterward a professor at University College, London, spoke to him, in the course of a walk, in the most enthusiastic manner of Lamarck and his views on evolution. Darwin listened to these views with interest, but was in no way impressed or convinced by them. The same is true of the "Zoonomia," and when he re-read it fifteen years later he was disappointed in it, "the proportion of speculation being so large to the facts given" (p. 38).

Thus Darwin was quite familiar with the views of his grandfather and of Lamarck, but it was not these that incited him to follow in the same paths; it was rather his own observations of nature that led him to abandon his old opinions, and it was only after long years of investigation, study, and doubt that he gained sufficient certainty to venture on giving his ideas to the world.

I must refrain from saying more about this journey, which was so fruitful for Darwin himself and for science; the two groups of facts of which I have spoken were undoubtedly decisive in their effect on his conception of nature. In December, 1836, with a wealth of great impressions and rich experiences in all the domains of natural science, his mind concentrated on the new idea of evolution, Darwin returned to his fatherland after an absence of five years.

Two years after his return he married, bought the estate of Down, in the county of Kent, and retired there to spend the whole of the rest of his life in constant work, but also in constant fellowship and personal touch with the most prominent naturalists of the day, who were readily accessible in London. He gradually came to have correspondence also with many naturalists in other countries.

His "chief pleasure and constant occupation" was his work, which sometimes even enabled him to forget the daily discomfort due to his health, which had been bad ever since his voyage. From the very beginning of the voyage he had suffered from severe and persistent seasickness, and his constitution had apparently suffered lasting injury, for in his autobiography he often speaks of being unable to work because of illness, and sometimes of having lost days and weeks, and one one occasion two whole years, from this cause.

In dealing with his work it is impossible for me to speak of all the important volumes he published in the course of his life. The first were the results of his voyage, various geological observations, and a new theory of the origin of coral islands.

Up till that time it had been believed that the so-called atolls, or lagoon reefs, had been simply built up by the coral polyps from the ocean floor until they finally reached the surface, where they formed flat

* An address delivered at the University of Freiburg on the occasion of the Centenary of Darwin. Reprinted from *The Contemporary Review*.

islands. Darwin recognized that the process could not be quite so simple, because the polyps cannot live at great depths. He therefore assumed that a secular subsidence of the ocean floor must have played a part, and this hypothesis not only explains in the most beautiful way the details of the structure of an atoll, but it has been brilliantly corroborated by later investigations, especially by borings on one of the islands, and the theory is now a permanent possession of science. After the completion of this volume he worked for eight years at the rich material he had brought from the coast of Chile, of that remarkable group of sedentary crustaceans, the Cirripedes, usually known as barnacles and acorn shells. Two thick volumes on this subject appeared in 1851, and later two other quarto volumes on fossil species of the same group. Even here, in this apparently dry and purely systematic province, the true spirit of the investigator revealed itself, for he did not neglect what was unintelligible to him, and therefore inconvenient for his theory, but devoted the most persistent attention to obscure points until he had found a solution of the difficulty. Thus he discovered that within the group there are species which, like all Cirripedes, are hermaphrodite, but which possess in addition small degenerate-looking males of different structure attached as parasites to the hermaphrodite animals. It is, however, only in our own day that it has become possible to understand the deeper significance of this important discovery.

In addition to these special pieces of work Darwin collected with untiring energy facts which had any bearing on the theory of transmutation, having begun in 1837, just after his return to England, a large collecting notebook, in which he entered all the facts referring to the variability of animals and plants, in particular of those which are under the care of man. By means of printed lists of questions, of conversations with expert breeders of animals and plants, and of wide reading in books and journals, he sought to lay the foundation of fact which he required in order to attain to clearness in regard to the supposed transformation of organisms.

He was very soon led to the conviction that the essential factor in the artificial modification of an animal or plant form was selection for breeding. But how could such selection take place in free nature? For a long time he was unable to find the answer to this question, until chance made him acquainted with the work of the economist Malthus on "Population," and the ideas developed in this book suggested to him the solution of the problem. Malthus showed that the human population multiplied much more rapidly than the means of subsistence could increase, and that therefore catastrophes must occur from time to time to diminish the excessive number of human beings. Darwin said to himself that in the rest of nature, among other forms of life also, an enormous number of individuals must perish, since all that were born could not survive, and since the greater part of a species furnishes food for some other species. Thus the ceaseless "struggle for existence" became clear to him, and suggested the question whether it was merely a matter of chance which of the many born should survive and which should perish. He concluded that the answer to this question was, evidently, that favorable variations would have more prospect of survival than unfavorable, and thus he discovered the principle of natural selection—that the principle at once so simple and so powerful, which alone enables us to understand the transmutation of organisms in adaptation to the conditions of their life. But it was a long time before Darwin ventured to publish this luminous idea. For his own satisfaction he wrote a rather short sketch of it in 1842, and in 1844 he expanded this to 230 pages; but it was not till the fifties that, urged by his friends Lyell and Hooker, he resolved to give his ideas to the world. Even then he might have delayed publication, but that in the meantime the same idea had occurred to Alfred Wallace, in Ternate, in the Malay Archipelago, and had been communicated by him, first to Darwin, and then through Darwin to Lyell and Hooker. Then followed the memorable meeting of the Linnean Society, London, in July, 1858, at which two papers were read, one written by Darwin, the other by Wallace, both setting forth the same far-reaching idea of evolution based upon the principle of selection—a beautiful example of the unenvying magnanimity of two great discoverers.

This private communication to a scientific society made no great stir. But the publication in the end of 1859 of Darwin's book, "The Origin of Species by Means of Natural Selection," attracted great attention. A new edition was called for on January 2, 1860, and during the twenty-two years between that time and 1882, the year of Darwin's death, one English edition followed another, and more than 24,000 copies were printed. During the same period one German edition succeeded another, and it is doubtful whether any other scientific book attained to such a circulation.

Yet the book is simple and straightforward, never sensational in style, but advancing quietly and concretely from one position to another, each supported by a mass of carefully sifted facts. Every possible objection is duly considered, and the decision is never anticipated, but all the arguments on both sides are carefully and impartially discussed in a manner that is apt to seem to the impatient reader almost too conscientious and cautious.

To readers who were acquainted with the scientific results of the time, who were aware of the numerous important facts that had been discovered, but missed the unifying idea which should gather them all together into a harmonious picture of life, the book came as a revelation. I myself was at the time in the stage of metamorphosis from a physician to a zoologist, and as far as philosophical views of nature were concerned I was a blank sheet of paper, a *tabula rasa*. I read the book first in 1861, at a single sitting, and with ever-growing enthusiasm. When I had finished it I stood firm on the basis of the evolution theory, and I have never seen reason to forsake it.

This must have been the case with many. You know that the generation at the beginning of the century, satiated with speculation, threw itself wholly into detailed research, and its whole endeavor was to acquire new facts. Darwin furnished the unifying idea for these: It was evolution. Almost the whole younger generation of naturalists ranged themselves at once on his side; the older generation gradually followed, first zoologists, then botanists; even my excellent friend, Anton de Bary, was only converted to the new views in 1880, and from that time onward there was little further opposition, even on the part of the botanist.

Although Darwin's book was straightforward and simple, its effect was nothing less than revolutionary; it upset the old, deep-rooted doctrine of creation just as completely as Erasmus Darwin, Lamarck, and Oken had desired. The book raised a conflagration like lightning in a full barn. This was soon so widespread that people read only "against" or "for" Darwin, especially in Germany, but later also in England. At first the opponents had the upper hand; the church regarded the new doctrine as dangerous to religion, because the old Mosaic mythus of creation could no longer be regarded as the basis of belief, and many of the older naturalists did not care to give up their inherited opinions without a struggle, and therefore strove to depreciate the new theory, either by serious argument or by satire and ridicule. The first to publish a work "for" Darwin was the German naturalist, Fritz Müller (1864), in Brazil. His book contained the first important deduction from the Darwinian theory; it went further than Darwin himself, and contained the germ of what Ernst Haeckel called, in his suggestive "Generelle Morphologie" (1866) the "fundamental biogenetic law." I myself was probably the third champion of Darwin's views when, in 1867, I delivered my academic inaugural address on "The Justification of the Darwinian Theory."

At that period almost every special study in the domain of embryology and "comparative anatomy" revealed fresh facts which were only intelligible on the assumption that the theory of descent was valid; much was now observed that had formerly been overlooked, simply because it was not understood, and much of the work done in the period of detailed investigation had to be done over again, because the points that were now most important had previously been disregarded. In this no reproach is implied to the many excellent observers of that period. No one can possibly observe everything that takes place; for instance, in the development of an animal, each notes only what seems to him to have some significance, whether he is able to interpret it or not. We do not work with our eyes alone; we must think at the same time.

But I need not dwell longer on the manner in which the Darwinian theory gained over the scientific workers of all countries, and penetrated deeply even among the laity. We have all had some personal experience of it, for the triumph of the theory of evolution has not long been won. A few words may be necessary as to why it was won so easily and so completely.

This was due in part to the enormous and increasing mass of facts in support of it, but mainly to Darwin's discovery of a principle capable of explaining transformations, in so far at least as these are "adaptations"—the principle of selection. Lamarck, too, had thought out a principle of explanation—the use or disuse of parts—but it was obviously insufficient to explain evolution as a whole, since it could only apply to actively functional organs.

The discovery of the principle of selection is the greatest achievement of Charles Darwin and his contemporary, Alfred Wallace, and it alone, in my opinion at least, affords a secure basis for the theory of evolution. It reveals to us how the apparently impossible becomes possible, how what is adapted to its purpose can have arisen without the intervention of a directing power.

(To be continued.)

Geology and Our National Resources

In his recent presidential address before the New York Academy of Sciences, Prof. J. A. Kemp took up the discussion of some of the problems which arise in connection with the ultimate limitations of our supply in raw materials derived from the earth's crust. The consideration of a number of special aspects of the situation was introduced by some reflections of a general character. Prof. Kemp says:

"The problems of the production of the metals and non-metalliferous substances, as we know them to-day, are of quite recent growth. High explosives, efficient engines and pumps, steam shovels and the like are all not so old as many men who are still living. They have so greatly reduced costs that practically a new world has opened to the miner. Not only on the surface or near it has he been able to work, but the depths have become accessible, and where the value of the ore justified the effort, no floods of water have sufficed to keep him out.

"These successes, coupled with ever-expanding markets, have until recently directed attention almost wholly toward discovery and production. But the last ten years have brought a further change. We are now less concerned about new discoveries than about the maintenance of old ones. We are not altogether intent on production, but are much given to forecasting and husbanding. From being solely an aid to the miner, the active worker, the producer, geology has become the colleague and helper of the economist, the statistician and the philosopher.

"Like all other changes in fundamental points of view, this one has not come with absolute suddenness. As far back as 1879 certain geologists and engineers began to raise and discuss the question of the duration of the Pennsylvania anthracite. In 1894 the late Richard P. Rothwell, long the able editor of the *Engineering and Mining Journal*, gave these coal fields a future of 70 to 100 years. Thus for over thirty years the question of their death has been a very live one. Even earlier the future of the coal fields of Great Britain came up for discussion. A parliamentary commission was appointed in 1866 and reported upon the question in 1871. For forty years anxiety has prevailed regarding the continued production of our petroleum wells, and naturally so. The very means of production of this useful source of heat and light starts a train of thought along the lines of its permanence.

"Some ten years ago the question of our reserves in iron ore began to excite interest. Mr. Andrew Carnegie gave most forcible expression to the feeling of alarm in his rectorial address in 1902, at the University of St. Andrews, Scotland. Mr. Carnegie was known from one end of the world to the other as one of our greatest ironmasters, and his words made a profound impression. In his address he assigned us only enough first-class ore to last for sixty or seventy years, and only enough of the inferior grades for thirty years thereafter. We all trembled for some years with the prospect of seeing our greatest industry in the production of metal disappearing within a century. Many thoughtful people began to wonder what would become of us with its extinction."

At this time, when the movement for the "preservation of our national resources" is the order of the day, it is interesting thus to call to mind the past history of the rise and origin of the modern policy.

M. Pierre Lesage of Paris states that he is able to show whether certain seeds are able to grow or not by placing them in potash solution. The seeds which are defective and are not good for planting are found to give a yellow color to the solution. At present he confined his experiments to one kind of seed, the hepidium sativum, using old seeds collected in 1888 to 1893, and comparing them with fresh seeds from 1909. He finds in general that the seeds which have lost their growing power will color the potash solution yellow, owing to the diffusion of a substance which he has not examined as yet. They do not produce this color in pure water, however. As to the time which is needed to give the yellow color, this is shorter than what is needed for grains of the same kind to sprout. For instance, using the old seeds from 1893, they showed a color in the solution in about four hours, while fresh seeds from 1909 took twenty hours to show a sprouting in the same conditions. Thus the process allows of gaining considerable time in observing the seeds. The present experiments are only in the first stages, but it will be seen that should we be able to find out at once whether certain seeds or grains are able to grow or not by a simple experiment, the result will be of great practical value. Other kinds of solutions will no doubt be found which can be used for testing seeds or grains in this way.

Reclamation of the Southern Louisiana Wet Prairie Lands—II*

By A. D. Morehouse, Office Engineer, Drainage Investigations

Concluded from Supplement No. 1843, page 270

METHODS OF RECLAMATION.

Early Methods.

SOME years ago systematic efforts looking toward the reclamation of these fertile marsh lands began, and it is interesting to note that as early as 1883-84, 1,300 acres were reclaimed by one company. During the great flood of 1884, however, the levees were broken and further work ceased for the time. Later, Mr. J. B. Watkins reclaimed a large area in southwestern Louisiana, and in "Tide Marshes of the United States" he gives the following description of his methods:

"Our plan of reclamation is to build dikes along the gulf, rivers, lakes, and bayous of sufficient height and strength to prevent overflow of each in the event of floods from rain and storm tides, and in this we will be assisted by the natural levees found in many places along these waters. We cut, parallel to each other, and one-half mile apart, canals 18 feet wide and 6 feet deep. At right angles with these, at intervals of 2½ miles, we cut larger canals, thus forming the land into oblong blocks one-half mile by 2½ miles, each containing 800 acres. Across these blocks at proper intervals we cut lateral ditches 30 inches deep by 8 inches wide at the bottom, flared to 30 inches wide at the top.

The canals are cut, the levees formed, and the dikes are, to a considerable extent, built by the use of powerful floating steam dredges. Smaller ditches are cut by ditchers propelled by steam power, passing through but once, at the rate of 1½ miles per hour.

"At proper localities we erect automatic flood gates, by means of which we control the stage of water in the canals, and the necessary volume of water is regulated to some extent by the ebb and flow of the tide. This is supplemented by the use of powerful wind pumps, and when the natural elements will not accomplish the work we readily move upon the canals to the spot our ditching, plowing, and cultivating engines and attach them to pumps. Thus arranged, with control of the water, these blocks of land are in condition for the most successful rice culture."

In the rice and sugar belt, in the southern part of the State, the land ranges from 2 to 8 feet or more above mean gulf level, and the swamps, bayous, bays, and rivers with which the section is interspersed furnish the outlet system by which the drainage water may be carried to the gulf. In a majority of cases it is necessary to levee a part or all of a plantation in order to protect it from the overflows in times of flood, and, also, in regions near the gulf coast, to protect it from backwater and high tides, especially at times when the prevailing southeast winds are blowing. At such times the waters along inland streams near the coast may be raised as much as from 3 to 5 feet from this cause. In this connection might be mentioned the fact that on the Matthews plantation in La Fourche Parish it was considered that usually the pumps had to operate only after a rainfall of 4 inches or more in twenty-four hours, but when the southern winds made high tides in the bayou they were started for as small as a 2-inch rainfall.

FIG. 8.—CONSTRUCTED CANAL SERVING AS OUTLET FOR TWO DISTRICTS AND AFFORDING GOOD TRANSPORTATION FACILITIES

Until very recent years the ditch systems for the reclamation of sugar lands were nearly identical. Often it seemed that the chief effort was simply to rid the land of the rainfall without much regard as to whether or not the drainage of the soil was secured. As most of the plantations ran from the bayous or streams back into the swamp, there was usually at least a slight fall away from the streams, and a series of parallel "leading" ditches from 6 to 10 feet wide and 2 to 4 feet deep, spaced from 800 to 1,200 feet apart, ran the length of the plantation. These were intersected at right angles, usually by ditches of similar size, at distances of 800 to 1,200 feet apart. These latter ditches were laid with no fall, so that the water would flow either way, dependent upon the height of the water surface in the "leading" ditches. Smaller "panel" ditches, 2 to 6 feet wide, 1½ to 3 feet deep, and placed every 90 to 120 feet, ran parallel to the leading ditches, thus dividing the land into blocks, locally known as "cuts." The cultivation of the crop was in rows parallel to these panel ditches and every 300 to 400 feet the furrows were crossed by shallow shovel ditches, known as "quarter drains," which caught the run-off from the furrows and led it into the panel ditches. After each cultivation it was necessary to go over these shallow drains with a shovel, in order to clear them out and make them effective. Large rainfalls were quickly disposed of by such a ditch system, but, owing to the shallow depth of the ditches, the drainage of the soil was not as effective as under more modern systems, and from 10 to 20 per cent of the cultivable area was taken up by the ditches, besides the inconvenience caused by the smallness of the plats to be cultivated. The cost of such a ditch system, not including levees or pumping equipment, would amount to over $2,000 for 80 acres, or an average of over $25 per acre.

PRESENT METHODS.

It is apparent from the experiences of the past that in the reclamation of small areas of land the cost might often be prohibitive, but as the size of the plantation increases, the cost per acre rapidly diminishes and probably approaches a minimum price when the plat of ground amounts to eight sections (5,120 acres) of land or more. Under ordinary circumstances, however, it would be difficult to find such a tract of land lying in regular shape and available for reclamation, hence there are few single projects thus far which have attained this size, although the impetus recently received in the matter of reclamation of these lands indicates that the undertakings will become larger and larger. The various main elements which enter into these projects are the levee system, seepage, outlet canal system, interior ditch system, and, lastly, the pumping plant.

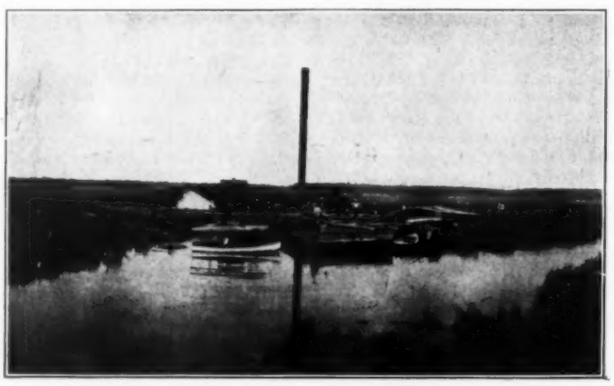


FIG. 9.—SAME VIEW AS FIG. 8, BUT SHOWING RESERVOIR CANAL OF DRAINAGE DISTRICT DAMMED ACROSS AND PUMPING PLANT BEING ERECTED

Levees and Seepage.

Sometimes the natural embankment or high ground adjacent to the bayou or river makes a levee unnecessary along the stream side of the plantation, but ordinarily the other three sides need such protection, wholly or in part, the height of the levees depending in large measure upon the proximity to the gulf and upon the elevation of the land surface respective to the high water in times of flood. Ordinarily the levees do not require such careful construction as those along streams subject to frequent and prolonged floods where the water often stands against the embankement for long periods, nor is it always so necessary to clean the entire levee site as in this latter case. It is always well, however, to remove all coarse vegetable matter, and a plowing up of the site is very desirable, in order to insure a good bond. The general specifications for levee construction and maintenance have been given in a previous publication of this Office. A muck ditch 2 or 3 feet in width and about 2 feet in depth, and approximately on the center line of the proposed levee, should be constructed, in order to insure against excessive seepage. Such seepage is liable to be the minimum in the fine close-textured silt soil back in the marshes. In the case of the Gheens plantation, La Fourche Paris, two parallel muck ditches spaced 25 feet apart are used under the levee.

Shrinkage of the levee should also be taken into account, and experience would indicate that levees in these soils built by means of shovels or wheelbarrows shrink about one-fifth of their gross height, while those constructed by wheel scrapers shrink one-eighth in height. Where an excavating machine is used in dry material the shrinkage is approximately one-sixth, and where excavated material is wet it is probably not more than one-tenth. In the latter case the spoil generally being from a greater depth and being well compacted during the construction usually insures less seepage than where hand work is performed and where the levee is constructed from the looser, coarser material nearer the surface. In order to prevent excessive seepage, it is preferable in constructing the levees to excavate the canals on the outside, leaving a sufficiently wide berm to prevent the spoil from sloughing back into the ditches. Unless care is exercised this is especially liable to occur in the soft prairie lands. The levees require for the first few years frequent additions in order to keep them to the required height, unless, when first constructed, shrinkage has been allowed for. In order to maintain them with as little care as possible, it is well to have them sodded to Bermuda or some native grass, which not only prevents them from washing, but also prevents the growth of weeds, brush, and other vegetation that

* This article is based on reports to the chief of drainage investigations, by A. M. Shaw, C.E., New Orleans, La., and Prof. W. B. Gregory, M.E., Tulane University, of their investigations made during 1909, and also upon data furnished by C. W. Okey, assistant drainage engineer, who continued the work of this Office during 1910 in Southern Louisiana. All quotations not otherwise credited are from the foregoing mentioned reports, the portions referring to pumping equipment being by Professor Gregory and the rest by Mr. Shaw.

would furnish shelter to the many borrowing animals which, ordinarily, occasion much annoyance and also damage to the levees. The sudden rise of outside waters often endangers levees on account of the increased seepage at such times, which is probably often due rather to the more porous nature of the soil above the ordinary water level than to the increased head. Such floods, however, develop all weak spots caused by muskrat holes and the like. When a failure occurs from this cause the outer end of the break should be immediately closed by a few shovelfuls of clay, planks, or sacks of earth, and a trench then dug across the levee. The tunnel made by the animal can then be filled with puddled clay and the damage thus remedied.

Canal Systems.

Where a plantation does not adjoin a bayou or other good outlet, it is often necessary to construct outfall canals for some distance, often through heavy timber, which, of course, greatly increases the cost of the reclamation work and calls for the co-operation of a number of land owners in order to make the plan feasible. These outfall canals, as well as those surrounding the levees, furnish good means of transportation by boat, and often the flow of water from the drainage plant will be sufficient to keep them scoured out, so that they require little attention. Such transportation routes, connecting as they do, with a series of lakes, bayous, and streams, place the various plantations in a comparatively independent attitude, so, even though not furnished with convenient railroad facilities, they are still within easy and convenient reach of good markets. Fig. 8 shows such a canal constructed as an outlet for two drainage districts. The small canal shown forms the reservoir of one of these districts, and, as shown by Fig. 9, it has been cut off from the outfall canal by an earth dam and the pumping plants, as appears, is in process of erection. Along the banks of these canals willows and cottonwoods, brush and weeds often grow, but as they are above water level they do not, as a rule, offer much interference to the flow of the stream. Another growth, however, that causes a great amount of annoyance and in some cases practically stops the flow of the water in the ditches is the water hyacinth, which is known locally as a lily. It is practically impossible to navigate through these obstructions, when once well established, except by the use of stern-wheel power boats. These plants, introduced from abroad, have rapidly spread through many of the southern streams, so that means for checking their growth or eradicating them entirely are eagerly sought. Fig. 7 shows a canal filled with these water hyacinths which have grown to about 18 inches above the water surface. The view shows the main discharge canal of a large plantation, and it can readily be understood how its efficiency is impaired by this pest. The following description of the plant is taken from a report by F. F. Shafer, drainage engineer:

"The plant when young has a bulbous stem, but as this grows upward the enlargement disappears, apparently being absorbed by the stem, which is cylindrical and hollow. The plant multiplies rapidly by sending out shoots or suckers from the base of the bulb, the shoots and roots seeming to start from the same place. The latter grow in feather-shaped tufts, presenting a large surface to the water. They are tender and break off readily, but, if not disturbed, grow downward 4 or 5 feet. In the latter part of May a flowering stem appears which bears a spike of odorless flowers, pale lavender in color, resembling the ordinary cultivated hyacinth. The stems reach a diameter of one-half to three-fourths of an inch, and in this vicinity frequently extend 3 feet above the water surface. Crowding does not seem to hinder the growth of the plant, and since it floats upon the surface of the water, wind, tide, and currents tend to produce closely packed masses. When a ditch becomes filled with these plants, the floating stems and roots offer a very serious obstruction to the flow of water. Two or three years of undisturbed growth in a ditch will greatly reduce its usefulness as a drainage channel. Booms are placed at the outlets of the drainage canals to prevent the plants from floating into the ditches, but it is difficult to prevent these booms being left open by people passing through in boats."

The attempt has been made to use poisonous chemicals for the eradication of these plants; this not only proved more or less ineffective, but the expense was far too great. On the Matthews plantation, before mentioned, an attachment in the shape of a gridiron some 7 by 8 feet in size was fastened to the dredge dipper and the plants dipped up and dumped on the banks in a similar maner to the operation of a dipper The plants, when exposed to the hot sun, soon die. The cost of removal by this method amounts to about 0.4 cent per square yard for the area cleaned. On other plantations, during the rainy periods the laborers use pitchforks to remove the water hyacinths from the ditches. If is often necessary to repeat the operation once or twice a month. The cost in this case is practically the same as by the use of the machine. In localities close to the gulf, where salt water prevails, the plants do not thrive.

Interior Ditch Systems.

Although somewhat dependent upon the size and shape of the area inclosed within the levees, the present general scheme of drainage is more or less the same throughout this region. This system usually includes a main "reservoir" canal, or canals, upon which, at some convenient place, a pumping plant is installed. Leading into these reservoirs are "collecting" ditches of somewhat smaller size, and at right angles to these latter are "lateral" ditches which are still smaller, and which usually feed into the collecting ditches, as on the Willswood plantation. In certain cases, as in the Smithport plantation, the collecting ditches are practically dispensed with and the lateral ditches discharge directly into the reservoirs. In addition to the laterals, shallow shovel ditches, corresponding to the old "quarter drains," are maintained at right angles to the furrows, and thus collect the water rapidly from the fields and discharge it into the ditch system. These latter are made new each year and they vary in arrangement and size to meet the individual requirements.

Although subject to variation, the main reservoir canals range in width from 30 to 60 feet and usually have a depth of from 5 to 8 feet. The deeper the canal the greater storage capacity it possesses and the better outlet it furnishes for the collecting ditches or laterals, as the case may be, and it is also less liable to water-growth obstructions. As shown in the following table, the reservoirs of the three plantations under investigation have varying capacities, equivalent to a rainfall on the tributary lands of from 0.1 inch to 0.4 inch. It would seem preferable to construct reservoirs having even greater capacity than the larger amount mentioned, as, by so doing, the size of the pumping plant can be decreased. This table from Mr. Shaw's report, besides showing the reservoir capacity, also gives the length of the various ditches and area occupied by them and gives, as well, the normal capacity of the pumping plant in inches of water depth per twenty-four hours. It will be noticed that the ditch systems of these three plantations only occupy from 3 to 6 per cent of the area, which is a decided decrease from the 10 and 20 per cent under the old ditching system, as previously mentioned.

Data of Ditch Systems.

Description.	Smithport.		Williswood.		District No. 2.	
	Length.	Area.	Length.	Area.	Length.	Area.
	Miles.	Acres.	Miles.	Acres.	Miles.	Acres.
Reservoirs	1.23	6.6	4.98	24.2	1.00	4.9
Collecting canals	1.38	2.0	17.16	24.9	7.31	10.0
Laterals	99.57	21.5	125.19	91.1	18.55	13.5
Totals	22.18	30.1	147.33	140.2	26.86	28.4
Proportion occupied by ditches, per cent.		4.65		5.84		3.02
Capacity of reservoir at flood stage in inches of rainfall over entire area		0.34		0.37		0.09
Approximate normal capacity of pumping plant in inches per 24 hours		1.11		1.45		1.23

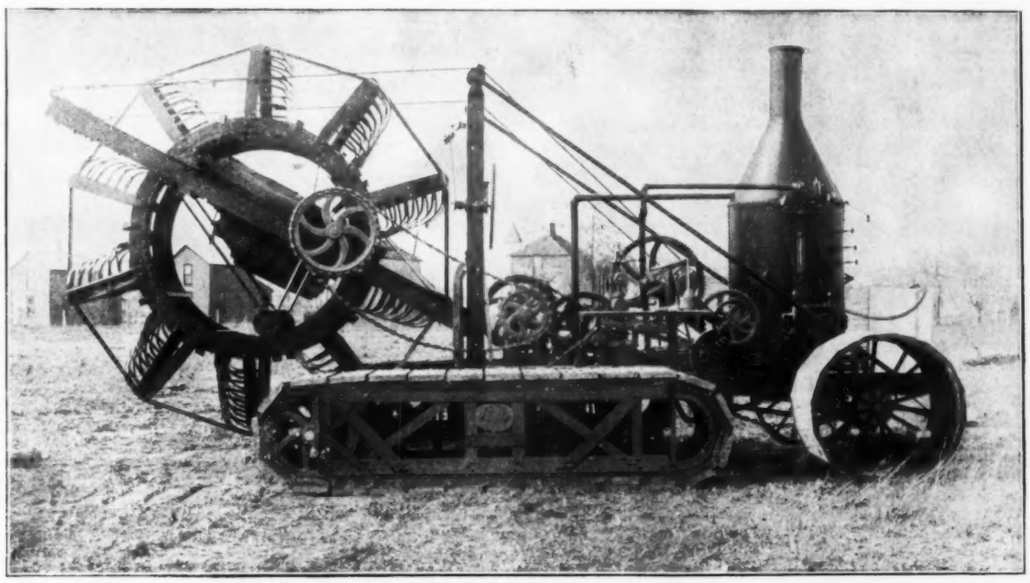


FIG. 10.—OPEN TRACTION DITCHER USED FOR DIGGING LATERAL DITCHES IN WET PRAIRIE LANDS. SOIL IS DEPOSITED AT ONE SIDE OF DITCH, LEAVING GOOD BERM

The arrangement of the collecting ditches largely depends upon the shape of the fields and the natural topography of the land, and also upon the method and kind of cultivation that is desired. The endeavor is to arrange them, however, so that they may get the water from the fields into the reservoir canals as promptly as possible. They vary from 4 to 10 feet in width and are usually maintained at a depth of from 4 to 5 feet.

Ordinarily, the lateral ditches in heavy soils are placed 100 feet apart and are dug some 3 feet deep, with bottom width of about 2 feet and a top width of about 4 feet. Formerly these laterals were dug entirely by hand, but a ditcher machine has been developed which now digs them with great rapidity as well as economy. A view of this machine may be seen in Fig. 10. All the larger ditches are constructed usually by floating dipper dredges having 1 or 1½-yard dippers, and the present contract price is about 7 cents per cubic yard.

Thus far drain tile has not been extensively used in this locality, as the nature of the soil and the slopes found are likely to introduce difficulties which will have to be overcome before underdrainage is universally adopted. It is probable that in the coarser, looser soils near the bayous and streams tile would be more effective than in the more impervious silt farther out in the swamps. If it can be successfully introduced so as to supersede in part the use of the smaller ditches, a gain in land area and in convenience of cultivation and in the effective draining and aeration of the soil would be the result. By proper care in protecting the joints, it is improbable that silting of the tile would give much trouble.

As a general thing, the water table of the plantations in southern Louisiana is carried at from 1½ to 3 feet beneath the surface, and it is well known that the greater depth is preferable, as, besides furnishing a greater depth for the roots of the growing crop, it also furnishes greater reservoir capacity in the soil to provide against excessive rainfall. It likewise makes possible a smaller pumping equipment. By keeping the pumps running during the winter season, when necessary, the water table is kept as low as possible, aeration of the soil takes place, and the soil is thus put in good physical condition.

Pumping Plants.

Some plantations are so situated that fairly satisfactory drainage can be secured by the installation of outlet gates through the levees, either automatic or hand regulated. These drain the system of reservoirs and ditches in times of sufficiently low water, but when the water outside the levees is higher than the outlet, of course the gates must be closed and the reservoirs depended upon to hold all the interior drainage water. A great majority, however, of the plantations which are reclaimed require the installation of a pumping plant in order to make the drainage system effective at all times and make the leveed area independent, with the possible exception of seepage, of everything except the rainfall. These pumping equipments vary greatly according to individual opinions and means, but each particular location should be studied carefully in connection with all its surrounding conditions in order to choose an installation whose first cost will be warranted by the benefits received, and also one the operating expense of which will be reasonable. A balance should also be struck between the economical reservoir capacity and the size of the pumping plant.

In years past a machine that has been greatly in favor, especially upon the sugar plantations, is the drainage wheel. This is made of any desired capacity and may vary in diameter up to perhaps 30 feet, with a width of from 5 to 7 feet. By proper gearing, usually a double reduction, the speed can be regulated to suit the case, but usually a peripheral velocity of 3 to 4 feet per second is maintained. It is probable that a speed of 5 feet is desirable, for, revolving at a greater velocity, the water is liable to be carried over, while with a slower one a portion of the water may flow back into the pit. These wheels are placed at the end of the main ditch, and when not in operation the flood gate in the levee is closed. When the circumference of the wheel fits closely in a smooth pit, with the lift not exceeding one-third the diameter of the wheel, and when running at the proper speed, such a wheel will handle a large quantity of water at a small cost. Although they have been made, ordinarily, by the individual plantation owners and the actual expense of the material and labor of the wheel itself is not excessive, still the large foundations required make them probably more expensive than some of the more modern installations.

Another machine sometimes used is the rotary or chamber-wheel pump. One objection to this form is that for the larger sizes the construction necessitates that the water be lifted about 10 feet, and in case the necessary lift is less than this there is lost work. They are also somewhat expensive and are limited to their normal rated capacities.

The centrifugal pump is especially adapted to varying lifts, for by the use of a discharge pipe whose end is submerged in the out-fall canal or bayou a siphon effect is produced so that the actual head against which the pump is working is simply the difference in elevation between the waters in the reservoir and in the outlet canal. These pumps, on account of the varying speed at which they can be operated, have discharges, for short periods of time, far in excess of their rated capacities, which is especially desirable in cases of excessive rainfalls of short duration. The ordinary type of centrifugal pump, made principally of cast iron, is somewhat used and can be installed with either vertical or horizontal shafts. In the latter case it can be direct-connected with the steam engine.

There is a special form of centrifugal pump particularly adapted to low lifts, that has been in use for a number of years and is doing most satisfactory work on a great many plantations, including three of the experimental tracts. It consists of a wide, submerged impeller wheel on a vertical shaft driven by belt or rope from the engine. The water rises through the large wooden body of the pump, flowing away through a wide discharge trough. Except the impeller, shaft, bearings, and pulley, the entire machine is of wood. This pump is of large capacity and is perhaps especially adapted to lifts up to 10 feet, although it is claimed that by the use of two or more wheels, set one above the other, water can be pumped against a head of 40 feet. The discharge trough or platform can be placed at any height required. If it is set at high-water mark, however, there would always be some waste of power when the water in the bayou or out-fall canal is less than this height.

As the necessary water lift in the plantations of this section varies from 3 to 10 feet, it is a matter of economy that the pump be chosen which will only raise the water the height that may be necessary at any particular time. This will avoid the necessity of purchasing an engine and boiler of too great capacity. In some plantations that have been visited it has been found that the effective lift was only one-half of the actual lift, which, it will be readily seen, is a great waste of fuel and plant capacity. When open flumes are used, which are placed at the ordinary water level, the water in flood times can be prevented from flowing back by means of flood gates placed in the flume.

As may be noted above in the description of the pumping equipments of the various plantations, the engines and boilers selected vary greatly. They should, however, be chosen with due regard to first cost, capacity, reliability, and economy of operation. On some of the old sugar plantations the condemned boilers from the sugar houses are used, and run at a low pressure. In cases where the plan is only operated a few days in each year the cost of operation is not such a determining feature as when the plants are called on for regular work during each month of the year. In this latter case it will probably pay to put more money into a better plant, including automatic, high-speed engines, feed-water heaters, and other fuel-saving devices. In the former case simple slide-valve engines with any suitable boiler are about all that will be required. A point to be kept in mind is that these plants are usually run by more or less inexperienced labor, and therefore complicated machinery should be avoided. Economy in plant capacity should not, however, prevent the selection of machinery of sufficient size to take care in as short a time as possible of the probable run-off from excessive storms, as upon such drainage depends the plantation's success.

Engineers and Journalists

Tools and Words

"ENGINEERS" and "journalists" are two very modern words, embodying two very modern ideas, yet they illustrate a contrast as old as humanity—the antithesis between tools and words, technical arts and religion, nature mastery and nature worship. At all times, however, and now more than ever before, representatives of each of these tendencies occasionally go over to the opposite camp.

The invention of a new tool leads to discoveries of undreamed-of things by thousands of the masters of world-knowledge. In the course of a century the magnifying glass is so greatly improved by a silk-worker, a glass-blower and a mechanic that dozens of professors win fame by discoveries which they could not have made without the improved tool, and which hundreds of other men could have made as well with it.

On the other hand, a profound thinker spins a web of living words that takes root and grows, like a mycelium, in a million brains, and in time produces new tools, as well as words.

The priests of forgotten religions sought to influence the sun, the lightning and the rain by pompous oratory, but the tool, the machine, gradually replaced the word as a more efficient controller of the forces of nature. Yet to this day the spoken or written word still exerts its mystic spell and sways the destinies of nations.

Engineers and journalists form two of the youngest of professions. The engineers move mountains and construct machines that vastly augment the power of man, the journalists exert equally great influence in the political and social world, yet both lack the prestige enjoyed by the older professions. In political influence the engineers are far surpassed by the journalists. The German Reichstag includes many journalists and writers, but not a single engineer, unless one is concealed in one of the factory directors who sit in the Reichstag. Yet the engineer, by his inventions and activities, exerts an immense practical influence in political economy.

Dr. George Biedenkapp, whose article in *Technische Monatshefte* is here freely summarized, points out that neither the engineering nor the journalistic profession is a unit, or recognizes a uniform standard of fitness. An astonishingly large part in the progress of engineering has been played by untutored laymen. Even so modern an invention as the steam engine includes among its developers the lawyer Porter and the merchant Corliss. In engineering enterprises university graduates work beside, and even under, men who have graduated from the factory. So in a great newspaper office a former typesetter may become the chief of a highly educated staff. This lawlessness is not only a symptom of youth, but also a reason why engineers and journalists should view without prejudice many things that would create scandal in the old, academically educated professions.

The influence of the press, itself a creation of the engineer, will go on increasing, and the engineers are extending their influence, not merely by their technical achievements, but by entering the ranks of journalism, which already contain many men of technical training. Many celebrated engineers and inventors have possessed great literary talent. James Watt was an admirable narrator, and so was the American inventor Worthington. Max Eyth and Heinrich Seidel were poets as well as engineers. Vauban, the famous French military engineer, was one of the earliest and most important writers on national economy. The German inventors Riggenbach and Siemens and the American Porter, the father of the quick-running steam engine, have left fascinating autobiographies. Friedrich Harkort, who erected one of the first German steam engine factories, and built one of the first German steamships, was an influential political writer.

Furthermore, the solution of the difficult problems of organization and economics which arise in industrial practice fit the industrial engineer for the position of social engineer. Abbé not only improved the microscope, but also endeavored to improve the conditions of factory life. Freese and Oechelhaeuser wrote essays on the labor question. The engineer's training offers many inducements to attempt to combine men, as well as iron and wood, into a perfect machine.

Or was it by pure chance that Vauban wrote on the principles of just taxation; that Eyth founded the German Agricultural Society; that Harkort interested himself in the political and social weal of his fellow countrymen?

Language and thought have derived great benefit from technical discoveries. If wheels, wagons, clocks, compasses, springs and screws had never been invented we should be poorer by thousands of words and ideas. Two centuries ago the French mathematician and philosopher, Sophie Germain, drew a plan of an exact science of politics in which the mutual actions and reactions of the elements of population were illustrated by the mechanical analogy of forces acting between material particles. This enrichment of language and thought will be accelerated by the influx of men of mathematical and mechanical training into the journalistic profession. Both journalism and politics will gain by this development, which is a necessary consequence of the overcrowded condition of the engineering profession. Max Eyth sought a position in vain, and Porter was twice forced from his post by commercial wisdom. The dependence of the engineer upon the factory owner or contractor may be more galling than even that of the journalist upon the publisher. The newspapers are continually devoting more attention to industrial and technical subjects, and no novel is complete without a description of an automobile or airship adventure. The door of journalism, therefore, is opened widely to the engineer, and thus the tool again becomes a power in the realm of the word.

Depth of Water and Speed.

A CURIOUS result of the speed tests of fast-driven vessels is the discovery, alleged to have been made in England, that the depth of water strongly influences the speed. But it is not true, as was until recently believed, that increase of depth is invariably attended by increase of speed.

Experiments with the "river class" of torpedo-boat destroyers have shown that at certain depths, it takes the same power to give a speed of twenty knots as to give a speed of twenty-two knots when the depth of water is forty-five feet. On the other hand, there are points of minimum resistance. For instance, a speed of thirty-two knots in sixty feet of water can be obtained with less horse-power than in two hundred feet. The result, it is claimed in England, is even better at forty feet.

It seems to be established that in moderate depths the square of the speed in knots divided by ten gives the depth of water in feet where a sudden increase of resistance is felt. It all depends upon the influence of the bottom of the water on wave formation.

Solid Ceilings Between Iron Girders

A Summary of German Studies

By Robert Grimshaw

THE German Association of Steel Manufacturers has prepared for the benefit of the public a work treating very thoroughly the subject of ceilings and girders; and although its main object is to systematize plans for the manufacturers of iron beams and girders, it will also be of great service to the makers of terra-cotta cement and other artificial blocks.

In Germany the conditions are somewhat different from those in England and America; but for all that, a study of these will be of use to architects and builders in both these latter countries.

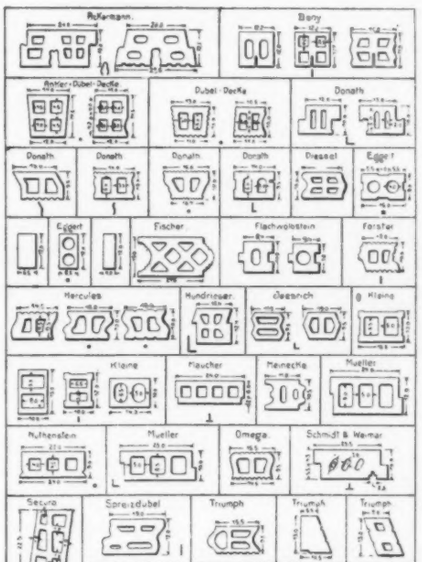
In Germany there are three general classes of ceilings—those with wooden joists, those constructed entirely of concrete, and those made of brick or tiles. The first class was in the early days the only kind in use, despite their insecurity from fire, which it was vainly attempted to do away with by impregnating them with alkaline solutions. In addition to this, they transmit sound very readily, which in these "piano days" is of importance in large cities. Against this difficulty all sorts of filling have been tried; but as one must reckon with the question of moisture, many of these materials become rotten and unhealthful. Further, the wood itself, when not properly seasoned and laid—and this is seldom done—gradually decays; and once fungus steps in there is no salvation. The trouble is brought from the forest, and as the timber cutters and lumber merchants have no particular interest in saving the lumber from destruction, once it has been sold, this trouble will be likely to continue indefinitely. The fungus, which is only about 2 millimeters or 0.078 inch long, passes through ordinary brick walls and infects one house from another.

All these disadvantages are missing in the two other classes of ceilings.

The concrete ceiling has its disadvantages also. In the first place, composing, as it should, a single built-together structure, it carries sound very readily, and is also a good conductor of heat to and from the rooms covered. This excludes it in many places from use in schools, hospitals and private dwellings. Concrete is also very heavy; alkalies from the cement are apt to appear on the surface, and the plastering does not adhere very well thereto; in fact, in this last particular the Berlin "Building Department" allows its use only in such cases as do not require plastering of the under layer.

The continuous nature of the concrete ceiling also renders difficult, if not impossible, any desired alteration. And finally the laying of such ceilings requires a skilled *personnel;* and it is often impracticable for the supervising architect to undertake any responsibility for the contractor, because he cannot sufficiently well control the main conditions for a good concrete ceiling—namely, the raw materials composing the mixture. The concrete ceiling, however, has its great advantages when it comes to the question of wide spans and heavy loads.

The hollow tile ceiling between iron beams avoids all the above mentioned disadvantages. In the first place, as against the wooden ceiling, it is absolutely fireproof—naturally, if provision is made that the beams or girders shall not be exposed to the direct action of the flames. Further, because the tiles are hollow it does not conduct sound; for the same reason, it is a bad conductor of heat. As it is composed of separate pieces which are not firmly bound together, alterations therein may be made without difficulty or expense. The ceiling plastering adheres well to the terra cotta; there is no danger of shrinking and expansion such as cause cracks in buildings where wooden ceilings are used. And finally, it is easy to inspect and to control material and workmanship, and no very skilled labor is necessary.



THE NAMES, FORMS AND CENTIMETER DIMENSIONS OF HOLLOW TILES IN USE IN GERMANY

The most simple kind of ceiling of its class is that in which there is a single arch between I-beams (which, by the way, the Germans always call "double-T-beams") of ordinary tiles, porous bricks or light artificial slabs of ashes and plaster or the like. Besides these there is a great number of more or less complicated fillings, some of which have found great favor, some very little or none. Among those which have been introduced with success in Germany are the Förester, "Sekura" and Klein types, which are shown in the accompanying illustration in alphabetical order.

As regards cost, it is indisputable that in most cases the wooden ceiling is the cheapest. A comparison of the cost of the concrete and the tile ceiling is difficult, as here the cost of the raw materials comes more into consideration.

The steel manufacturers have endeavored to aid builders in this particular, and have come to the conclusions stated below.

In the first place, they have figured up an ordinary apartment house. The cost per square meter (10.76 square feet) of all-wooden ceiling and floor is 11.25 marks ($2.68); of reinforced concrete with wooden floor covering, 13.25 marks ($3.16); hollow tile with wooden floor covering, 12.95 marks ($3.08). For a "one-family" house, reinforced concrete with wooden floor covering, 13.80 marks ($3.28); hollow tile with wooden floor covering, 12.30 marks ($2.93). In this connection the manufacturers of tiles should look to their own interests by reducing the cost of their tiles and of laying; also by preventing the wasteful use of mortar, as for instance where it runs into the hollows of the tiles. The practice of drawing paper tubes through the latter to prevent this is expensive. Closed tiles, such as were exhibited in the last "Clay Industry Exhibition" in Berlin, will avoid this difficulty.

The illustrations show about all the forms of hollow tiles which are in use in Germany; the dimensions being given in centimeters (0.39 inch).

In cost-figuring, the mark may be taken as exactly 23.83 cents; the square meter as 10.764 square feet.

Some Interesting Storage Battery Plate Potentials

BY PAUL F. TROUT.

IN experimenting to find a satisfactory substitute for the stick of metallic cadmium which is most commonly used in storage battery work when reading the charge on the separate plates, I secured some very interesting results. My purpose in conducting the experiments was to discover a means of taking complete battery readings where it was for any reason impossible to secure a stick of the comparatively rare cadmium. This will be of especial importance to the man who must install peak-load batteries in plants far from a large city.

I confined my experiments to lead sticks free from any other metal, because lead is always obtainable around a storage battery. The sticks were taken in various states of oxidation, and the following figures are representative of the readings obtained. The readings were taken on cells containing Tate bifunctional accumulators with electrolyte of specific gravity 1.215.

Some Interesting Storage Battery Plate Potentials.

Cells.	Volts.	Cadmium.		Lead Peroxide.		Spongy Lead.		Unoxidized Lead.	
		+	−	+	−	+	−	+	−
1	2.74	2.40	0.33	0.20	2.52	2.20	0.49	2.06	0.52
2	2.73	2.40	0.32	0.20	2.52	2.20	0.49	1.90	0.50
3	2.80	2.38	0.38	0.20	2.60	2.28	0.54	1.92	0.56
4	2.45	2.34	0.07	0.22	2.24	.....	..	.....	..
5	2.44	2.34	0.06	0.21	2.23	.....	..	.....	..
6	2.44	2.34	0.08	0.21	2.24	.....	.....	.....	..
7	2.43	2.34	0.06	0.21	2.22	.....	.....	.....	..
8	2.46	2.35	0.09	0.22	2.26	.....	..	.....	..
9	2.54	2.34	0.18	0.21	2.35	.....	.....	.....	..
10	2.68	2.34	0.31	0.21	2.48	.....	..	.....	..
11	2.65	2.35	0.22	0.22	2.45	.....	.....	.....	..
12	2.41	2.35	0.05	0.22	2.21	.....	.....	.....	.....
13	2.45	2.35	0.08	0.22	2.24	.....	.....	.....	.....

As can be readily seen from the figures, spongy lead and unoxidized lead proved so uncertain and unreliable that I soon abandoned them entirely. Lead peroxide was as reliable in giving an indication on the voltmeter as the stick of cadmium. Its one disadvantage lies in the fact that it requires more care in its handling than does the cadmium. I formed the lead peroxide stick together with the stick of spongy lead in an electrolyte of a specific gravity of 1.400 at a rate of six amperes, assisting the Plante formation by the addition of some hydrochloric acid and hydrogen peroxide. I charged in one direction all the time, in spite of the fact that to reverse the direction of the current tends to deepen the layer of oxide. I wanted the layer of oxide to be as compact as possible, and thought that to reverse the current would result in softening it too much. A deep layer of soft oxide might have increased the uncertainty of the readings.

The lead peroxide stick showed some rather peculiar characteristics. For instance, when it was taken out of the 1.400 specific gravity acid and used for a reading, it caused the volt meter needle to waver up and down the scale in a very unsteady manner. But it was all right after it had been washed in dilute acid. It gave the best results after it had been washed in water and dried, retaining its efficiency or capacity to give a steady indication to the volt meter needle for over an hour after being immersed in the electrolyte. It is useless if kept for any length of time in distilled water. Like the cadmium stick, it must be inclosed in a piece of rubber hose with small holes cut in it to admit the electrolyte. Most battery authorities say that the purpose of this rubber jacket is to keep the stick from touching the sides of the jar or the plates of the cell, but my experiments lead me to the conclusion that its real effect is to minimize the electro-chemical action on the stick.

It is interesting to account for the indications which these different substances give on the volt meter needle. First it is well to understand the part which the stick of oxide plays when it is immersed in the electrolyte of a cell. In every case the stick, no matter what its composition, plays the part of a negative plate when it is used in reading the charge on the positive plate, and the part of a positive plate when reading the charge on the negative plate of the cell. Cadmium sticks are always allowed to sulphate before they are used, thus giving a stick of cadmium sulphate which acts, when used in taking a reading, as a completely discharged plate. Lead peroxide, on the other hand, is in reality a fully charged positive plate, and consequently it gives indications with the volt meter needle which are strongly the opposite of those given by the stick of cadmium sulphate, but nevertheless they are always relatively the same in value. For instance, a given indication with a stick of cadmium sulphate will always be equivalent to a certain indication with a stick of lead peroxide. From this it can be readily seen that it would only require a series of carefully-taken readings to make a table showing the relative values of the indications given by the two sticks all through charge and discharge of a battery.

Excavations at Delos.—Excavation work is still continuing at Delos by archæologists connected with the French School of Athens, with funds furnished by Duc de Laubat. Among the late finds is a sanctuary devoted to an Egyptian cult. It was built on the slope of the Inopos and dates from the third century B. C., according to Messrs. Roussel and Picard, who discovered it. The latter archæologist also uncovered the ground around the Sacred Lake and great stadium which was situated at the northeast end of the lake. Many inscriptions were found on this spot. He also explored the Roman walls of Delos, these being built by Trarius in 70 B. C.

A Gravity Service for Handling Bricks

A Remarkable Labor-Saving Device

By Frank C. Perkins

MANY and varied are the labor-saving devices scattered through all departments of the industry and commerce of the present day. The desired result may be obtained sometimes merely through the assistance rendered to the hand by some specially designed tool, or by a particularly favorable arrangement of parts. Often, however, the contrivance employed does more than this, it supplies the power which is required for the work incident to the operation. The source of power is on the whole immaterial, so long as it satisfies the ordinary requirements of convenience and cheapness. A source of energy which in certain cases eminently fulfils these conditions is the gravitational work which all bodies are ready at all times and in all places to perform, as soon as they are given an opportunity to travel downhill. And in point of fact "gravity feed" is resorted to upon innumerable occasions in technical work. A special instance of this kind is depicted in our illustrations, which display several aspects of a gravity brick conveyer. As will be seen by referring to our illustration, and for detail especially to Fig. 2, the conveyer consists simply of a roadway or bed, whose bottom is formed of a series of transverse rollers, upon which the bricks are laid, and over the gently downward slope of which they proceed to their destination, whether this be the brick-stack in the factory in which they are made, as in Fig. 1, or the car (Fig. 4) in which they are to be shipped, or what not.

Some of the details of construction are exhibited in Fig. 2. It will be seen that the rollers are mounted upon ball bearings. The main portion of these rollers are cylindrical in shape, but at the curves in the line they are made conical, so as to give the requisite inward tilt to the moving material.

Ten years ago little thought had been given to the great possibilities of gravity conveyers for transporting merchandise from point to point in and about factory plants. To-day the system is a recognized element in factory and warehouse economy; its development has been rapid and scientific. Practical men in all lines of manufacturing recognized its value the moment it was brought to their attention, perceiving that its chief merits lay in economy of labor and time, the two great essentials in profitable manufacturing. The use of the gravity system often reduces the loading expense one-half over older methods besides making it possible to load more cars in a day than under former conditions.

FIG. 1.—GRAVITY BRICK CONVEYOR AT THE WORKS OF THE LAWRENCE VITRIFIED BRICK AND TILE COMPANY, KANSAS

FIG. 4.—LOADING BRICK UPON GONDOLA CAR

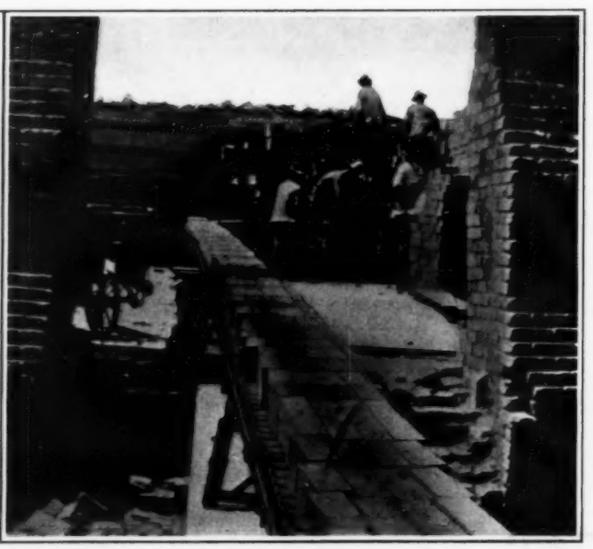


FIG. 5.—KILN END OF CONVEYOR

GRAVITY SERVICE FOR HANDLING BRICKS

Progress in Locomotive Design

THE most remarkable step in the progress of steam locomotive design that has been made for many years is without doubt, says the *London Times*, the new method of arranging the cylinders which has just been introduced by the Nord Railway in France. This method, which consists in placing the inside cylinders one in front of the other instead of side by side, according to the common plan adhered to until now since the earliest days of inside-cylinder locomotives, postpones to some undetermined period the limitation of the diameter of inside cylinders.

For many years past, writers have urged that finality in constructional limits for powerful locomotives would shortly be attained by reason of the impossibility of introducing cylinders of sufficient size for the power required within such limited loading gages as those of England and France. It was in 1889 that

M. Polonceau, of the Paris-Orleans Railway, affirmed that the French gage did not permit the building of two-cylinder compound locomotives of economical design, for the reason that the low-pressure cylinder could not be made large enough to allow of an economical second expansion of the steam, and the French railways thereafter adopted the multiple-cylinder compound system for rather small locomotives. Now, over twenty years later, in building the largest and most powerful railway engines yet constructed on this side of the Atlantic, the Nord Railway has found that even for four-cylinder engines, as hitherto built all over the world with side-by-side cylinders, the limits to the dimensions of low-pressure cylinders have been reached, and to overcome this difficulty the cylinders for its new "Baltic" type locomotives have been placed zig-zag, one just in front of the other. This arrangement enables cylinders to be made nearly half as large again as compared with the ordinary side-by-side arrangement.

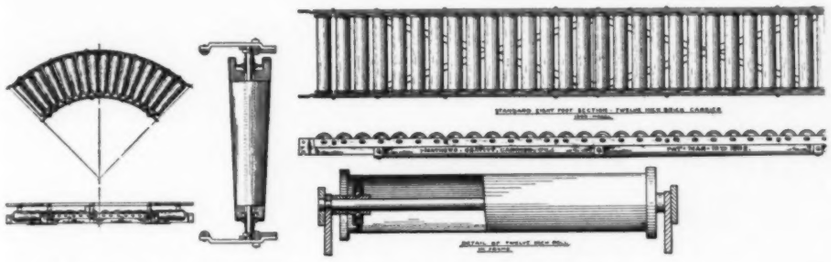


FIG. 2.—DETAILS OF CONSTRUCTION OF BRICK-CARRIER, SHOWING BALL BEARINGS AND THE CONICAL ROLLERS AT A CURVE

ADVANTAGES OF THE NORD SYSTEM.

The new method adopted for the Nord Railway by M. Asselin, the new chief engineer of motive power, is of great interest to every main-line locomotive engineer, not so much for the ingenuity of the design, with one piston rod working through the wall of the adjoining cylinder barrel, as for the key it presents for the solution of the many problems in construction which have arisen as a consequence of the great increase in the size of locomotives, and which involve, notably, the dimensions of the webs in cranked axles, the width of the connecting rod big ends, and the length of the journals.

With the Nord system the centers of the two inside cylinders are brought very close together, so allowing of considerable amplification of parts in the machinery, which until now have been gradually thinned down to accommodate the lessened space available between the connecting rods and the frames in engines fitted with very large inside cylinders, such as have become common with the use of "expanded" or superheated steam, as also for the low steam pressure expansion in compound locomotives. A great increase in the strength of turning parts now becomes possible, and this, considering the danger attending the failure of a cranked axle, adds to the value of the immense power augmentation possible in the cylinders of either two-cylinder or four-cylinder engines.

The new arrangement is of utility for any class of steam locomotive, but it is of greatest value in low-pressure engines requiring large cylinders. At the present time there is a tendency to return to low steam pressures in order to economize in boiler repairs. To utilize these low pressures the piston areas have been increased correspondingly, for, given the possibility of using very large pistons, the return to pressures of 120 pounds, even with saturated steam, becomes quite practicable, and examples of very low steam pressures in saturated steam compound and simple engines are now to be found in current European practice.

ECONOMY OF LARGE CYLINDER RATIOS.

The chief value of the Nord system for compound engines lies in the fact that it permits the use of low-pressure cylinders having a rational volume three times greater than the high-pressure cylinders. This ratio of volumes, 1:3, has been found in practice to increase the efficiency of the compound engine per unit weight of volume of steam consumed by at least 35 per cent with respect to single expansion of the same quality of steam in a similar type of "simple" engine; that is, each pound, or cubic volume, of steam develops 35 per cent more horse-power, averaged for a period of several years' consecutive working, than the same weight or volume of steam expanded once only in a similar type of locomotive working the same fast express train services. This economy, however, becomes less and less as the difference between the volumes of the two expansions decreases. With small low-pressure cylinders of only twice the volume of the high-pressure cylinders it is found that the increase of efficiency averages only about 5 per cent, while with a low-pressure cylinder volume of 2½ times the high-pressure volume the increase of efficiency is about 18 to 20 per cent. This experience has been common to practically all countries where two-stage expansion is used in locomotives, and it shows the great value of large ratios of cylinder volumes if the construction gage permits of them.

LARGER CYLINDERS POSSIBLE.

Hitherto, in both England and France, the realization of the great economy possible by two-stage expansion has been restricted by the limits of the loading gage, but the new "stepped" cylinder arrangement of the Nord Railway entirely removes this disability, especially if it is combined with certain differences in the frame plates as employed for several years in France and Belgium—that is, perforations in the frames allowing the inside cylinder to project through to the outside by a few inches and so considerably increasing their volume.

The new "Baltic" type engines of the Nord have straight, unperforated frames, and additional volume has been gained by lengthening the cylinders according to the practice of Bavarian builders. There are certain objections to this practice of lengthening the stroke, and an alternative arrangement, common in Italy, consists in mounting the inside cylinders clear above the frames so that they may project over the edges of the frames, without interfering with the outside cylinders placed on the same transverse level.

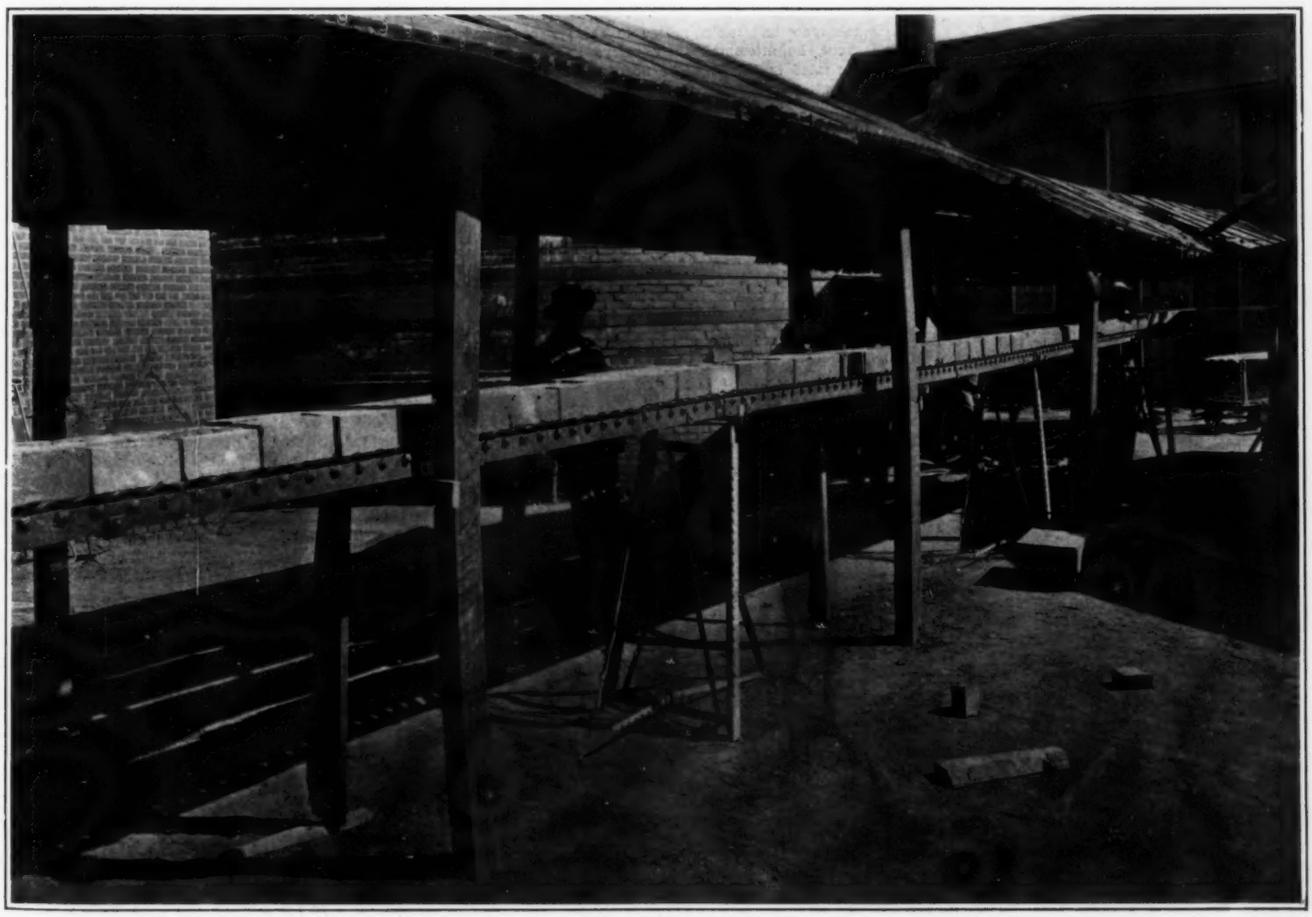


FIG. 3.—FROM KILN TO CAR BY GRAVITY.

GRAVITY SERVICE FOR HANDLING BRICKS

With the Nord "stepped" cylinders and the Italian plate frames it becomes quite practicable to build two-cylinder compound locomotives having one 23-inch and one 40-inch cylinder, both set very closely and compactly together inside the frames, and able to develop the same power at full speeds as much more complicated four-cylinder, non-compound locomotives with four 16-inch cylinders. With an equal weight of steam from the boiler in each case the one 23-inch cylinder working single expansion develops the same power as two 16-inch cylinders. In compound expansion the one 23-inch cylinder develops less power on a given steam admission, for the reason that, with cylinders of 1:3 ratio, its power capacity is reduced by the back pressure about 15 per cent, but this exhaust steam, producing the back pressure, develops on the low pressure piston a power which is equivalent to the total effective power developed in the high-pressure cylinder. That is, if 500 horse-power is developed by boiler steam in the high-pressure cylinder, about 500 horse-power is developed by the high-pressure exhaust steam in the large cylinders; and the larger the low-pressure cylinders are made the less is the loss by the back pressure in the small cylinders and the greater is the total load on the large pistons. With a loss of 15 per cent in the area of the high-pressure cylinder indicator diagram, the net economy by the two-stage operation is 50 per cent—15 per cent = 35 per cent.

These figures are confirmed by years of practical experience on railways using large cylinder ratios where there is no restriction to the size of the low-pressure cylinders. In general with such ratios, one-third less steam is required for a given horse-power, or one-third more power is produced on a given fuel or steam consumption. But this result is dependent on high cylinder ratios, such as are now rendered feasible for the most restricted main-line loading gages of Europe. The importance of the saving that could thus be effected is apparent from the fact that with, say, 100 compound locomotives the coal consumed would be worth £65,000 annually, whereas with the same number of simple-expansion engines, working with the same pressure and temperature of steam in the same train services, it would be worth £100,000. Further, with the Nord system it becomes practicable to develop the two-cylinder type with its advantages of simplicity as compared with the far more complicated and expensive four-cylinder non-compound engine. In all details, except in the boiler, the locomotive designers of all countries are seeking for simplicity, and the Nord arrangement especially appeals to those who would avoid four-cylinder engines of any type.

Salving the German Submarine Boat "U 3"

An Authoritative Account

On January 17th, 1911, the German submarine boat "U 3" was sunk in the harbor of Kiel (Fig. 1) by the imperfect closure of the after ventilation pipe. The depth of water was about 40 feet, and the stern of the vessel penetrated several yards in the soft clay bottom. As the boat sank her irregular movements were observed by the submarine "U 1," which hastened to the spot, launched a folding boat to pick up the telephone buoy of the "U 3," and then notified a warship, which transmitted the news to the Kiel dock yard so promptly that two steamers and a crane were dispatched 28 minutes after the vessel sank. Meanwhile the imprisoned men had informed the folding boat by telephone that the after part of the "U 3" was full of water. Communication then ceased.

The disaster was observed also by the lookout stationed on the Kaiser Wilhelm Canal and by the canal pilot steamer, which soon arrived on the scene and endeavored, with the aid of a tug, to tow to shore the foundered submarine, the bow of which had risen to the surface. The attempt failed, as the stern of the submarine was held down by some 100 tons of water. The crane arrived about an hour after the disaster, and with the aid of divers attached to the canal ser-

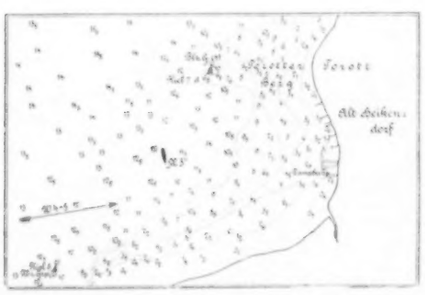


Fig. 1.—Part of the Harbor of Kiel, Showing Position of the Foundered Submarine Boat "U 3"

(The arrow and its inscription show the direction of the wind and its velocity in meters per second. The other figures indicate depths of water, in meters.)

vice preparations to raise the sunken boat were commenced.

It appears probable that the extent of the leakage was not, at first, fully appreciated by the crew of the "U 3," as the partly opened valve was invisible and inaccessible, and the mouth of the ventilation pipe, through which the water entered the hull, was covered and concealed by the motor. Hence the inrush of water could only be heard, and the water was not seen until it had reached the floor of the engine room. It was then too late to take effective measures. The boat sank stern foremost, and its position aggravated the evil by increasing the hydrostatic pressure at the leak, and in other ways.

The tanks, which had been so nearly filled, in preparation for diving, that only one ton of buoyancy remained before the accident, were emptied by pumping and by compressed air. Meanwhile the compartment bulkheads were closed, the emergency weights dropped and the telephone and lifting buoys set afloat. An attempt was then made to pump out the engine room bilge, but the pump would not "draw," owing to the position of the vessel. The water soon short-circuited some of the accumulators, producing results far more serious than the stoppage of the useless pump. The sudden discharge so heated the forward cells, which were not yet submerged, that several plates became red hot and some of the hard rubber parts took fire. The heated cells evolved suffocating sulphurous and acid fumes, which caused the commander to order a retreat to the forward or torpedo compartment. The commander, with two other officers, remained in the middle compartment and turret and continued the work of emptying the forward tank by means of compressed air until the bow of the boat rose 20 inches above the surface of the water. The 28 men imprisoned in the torpedo compartment

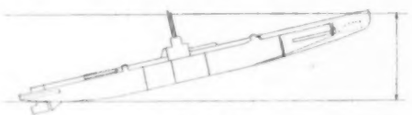


Fig. 2

owe their lives to this wise and heroic action of Lieut.-Commander Fischer and to the stanchness of the collision bulkhead which separated them from the turret compartment.

At 11:30 A. M., 65 minutes after the accident occurred, an inspector of the torpedo service arrived on the scene and found the sunken vessel in the position described above, with the prow and the periscope emerging slightly from the water and the stern embedded in the clay bottom (Fig. 2). Assuming that the crew had taken refuge in the forward compartment, he attempted their rescue by the method illustrated in Fig. 3. The floating crane (represented by the large rectangle) was anchored close to the weather side of the "U 3" and made fast by a chain passed around the submarine with the aid of divers. (The small rectangle represents the divers' boat, moored on the lee side of the "U 3.") Meanwhile other divers were working to attach the main tackle of the crane to the forward lifting hook of the "U 3." The latter task was not accomplished until nearly 3 P. M. Soon after that hour the bow of the submarine was slowly raised by hauling on the main tackle and occasionally tightening the chain stirrup until the forehatch was just awash (Fig. 4). The operation was then stopped in order to communicate with the imprisoned men by tapping, according to the

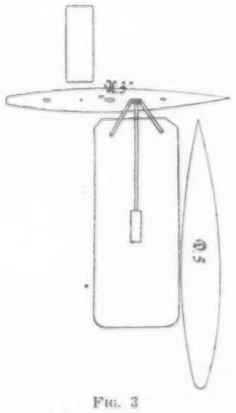


Fig. 3

Morse code, on the exposed part of the hull. The first attempts were frustrated by irregular knocking from the inside. It was afterwards learned that the imprisoned men were fastening the bulkhead doors, which opened inward (forward) and consequently did not entirely exclude the poisonous gases which were forced upward from the central compartment by the pressure of the water. After this work had been finished communication in Morse signals was established, and the imprisoned men reported "All is well." When they learned that the bow was out of water they announced their intention of opening the torpedo launching tubes. Boats provided with sounding lines were then stationed beneath the mouths of the torpedo tubes and the bow of the "U 3" was lowered until these mouths nearly touched the water. Meanwhile the imprisoned men, working by the light of a single pocket lantern, had succeeded in opening the starboard torpedo tube. At 4:30 P. M. the first man was drawn out by means of the sounding line. The work of rescue proceeded smoothly until an increased influx of poisonous gases caused the man who was being drawn out to let go the line and fall back unconscious. A call was then made for volunteers to go down and attach the imprisoned men to the line. In this way several men were rescued by a boatswain's mate, who was finally drawn out unconscious. Two officers, carrying an electric lamp connected with a cable, and a compressed air tube from the "D 5," which was moored beside the crane (Fig. 3), then went down and rescued the remaining men, most of whom were unconscious. The work of rescue was completed at 5:20 P. M. The starboard torpedo tube was necessarily left open.

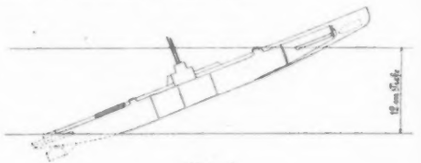


Fig. 4

Nearly one-third of the men rescued from the forward compartment were unconscious. They were taken to the lower deck of the crane float and revived by oxygen inhalations and other treatment. In less than two hours they were in condition to be removed to a hospital, where most of them fully recovered in a few days..

During the work of rescue preparations were made to raise the stern of the "U 3" in order to rescue the captain and the other two officers who were imprisoned in the turret. For this purpose a stout cable was attached by divers to the after lifting hook of the sunken boat. At the same time efforts were made to put into service the emergency ventilating apparatus, but the attempt failed because, as was learned aferward, the valves in the middle compartment were closed.

Meanwhile, imperfect communication with the imprisoned officers had been established by means of a board on which questions were written and which was held in front of the periscope. The prisoners answered "Yes" and "No" by turning the periscope to left and right. This conversation continued from 2 to 5 P. M.

The hawser which had been fastened to the after part of the "U 3" was attached to a second and more powerful crane (Fig. 5). At 5:30 P. M., ten minutes after the last man had left the torpedo tube, this second crane began hauling with great caution, pausing at intervals to give the stern of the "U 3" time to work out of the soft clay in which it was imbedded, while the forward crane exerted a steady pull of about 100 tons. When the stern of the "U 3" had thus been raised about 4 feet, the hawser parted and the boat sank back. The divers then substituted two new hawsers for the broken one, and the work of raising the vessel was resumed at 6:30 P. M., but the operation was soon stopped and the fate of the imprisoned

officers sealed by the breaking of a post of the after crane.

These two failures proved that the "U 3" could not be raised in this way. Nothing remained but to raise the sunken boat by means of the salvage ship "Vulcan" a sure but tedious method, which practically excluded all hope of saving the lives of the three heroic officers.

The "Vulcan" was used, in connection with the submarines "U 3" and "U 1," as a school of submarine navigation, the pupils and the crews of the sub-

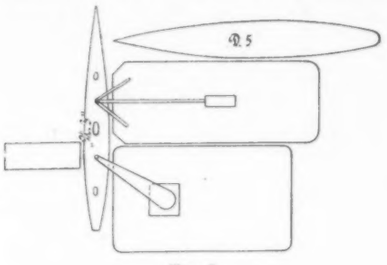


FIG. 5

marines being quartered on the "mother" ship. There was good reason for her previous inaction and her absence at the moment of the disaster which need not be explained here.

On the morning when the accident occurred the "Vulcan" was in dock at Kiel, and for this reason the submarines were practising in Kiel harbor, one always remaining afloat when the other dived. The "Vulcan" arrived on the scene at 1:30 P. M., but remained idle because it would have taken her at least six hours to raise the "U 3," which, even in its lowest position (Fig. 6) was too high to allow the "Vulcan" to employ her usual and most expeditious method of anchoring, at bow and stern, to windward of the sunken vessel and drifting over it.

After the crane broke the best method of employing the "Vulcan" was discussed, and every detail was decided, while the divers detached the hawsers and the sling from the "U 3." The disabled crane was removed and the other crane was drawn back about 40 yards. The scene was brightly illuminated by the searchlights of two vessels. The "U 3" now lay in the position shown in Fig. 6, entirely under water, though the top of the periscope could be seen just beneath the surface. The positions of the periscope and the bow were marked by small boats.

The difficult work of the divers was not completed until 8:55 P. M. Then the "Vulcan" was brought alongside the remaining crane and attached by bow and stern lines (Fig. 7). With the aid of these lines the "Vulcan" was swung around through a right angle, so that she lay parallel to the "U 3," and was held in this position by the starboard stern anchor, which had been dropped midway (Fig. 7).

The moorings of the "Vulcan" and the crane were then cautiously relaxed and the two vessels, retaining their relative positions, were allowed to drift toward the "U 3," until the bow of the double-hulled "Vulcan" was directly over the stern of the sunken vessel and immediately behind the periscope (Fig. 8). Now came the delicate task of moving the "Vulcan" forward with one of its twin hulls on each side of the "U 3," without breaking the periscope and thus flooding the turret and central compartment. This maneuver, the difficulty of which was increased by a strong side wind, was successfully accomplished with the aid of the port stern anchor and several small steamers which served as bow anchors and tugs.

The "Vulcan" was thus brought into the position shown in Fig. 9, with her hoisting tackle directly over the lifting hooks of the "U 3." The tackle was attached by divers (a task which occupied two hours) and the work of hoisting began to 4 A. M. The turret appeared above water at 4:35, and was opened ten minutes later. The abnormal pressure in the confined space caused an outrush of foul air, which smelled strongly of chlorine. The turret was ventilated with compressed air, a lamp attached to an electric cable was lowered, and two officers entered. They found their three ill-fated comrades dead at their posts in peaceful attitudes, which appeared to exclude all possibility of a death struggle. Although they had evidently been dead for hours, two hours were employed in fruitless attempts at resuscitation.

After the bodies had been removed, the turret was closed and the "U 3" was securely fastened to the "Vulcan," brought into the inner harbor and docked without difficulty.—Condensed from *Marine Rundschau*.

Improvements in Street-car Wheels

BEFORE the Alabama Light and Traction Association Mr. S. M. Coffin recently read a paper on improvements in street-car wheels, in which he reviewed the developments in weight, size and shape of car wheels, and detailed the experience with steel wheels of the Mobile Light and Traction Company. The company have two makes of wheels, which vary in weight from 500 pounds to 645 pounds per wheel, with a rim thickness of 2½ inches to 3 inches, and web thickness ¾ inch to 1¾ inches, with 2½ inch tread, or 3 11/16-

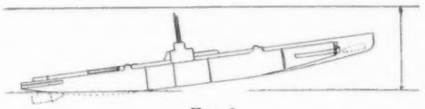


FIG. 6

inch width of rim, and also varying considerably in hardness. Two pairs tried under a single-truck car have shown more difference in wear than any others. For instance, one pair ran but 21,856 miles with a wear of 0.0183 inch per 1,000 miles, and had to be turned. This took off 0.0272 inch per 1,000 miles, or about 50 per cent more than the wear. They then ran 19,400 miles, with 0.0231 inch per 1,000 miles. They were then taken out, and the one which had developed a thick flange was ground 0.13 inch, making it 0.05 inch smaller than its mate, which was not touched. After this the wheels made 24,180 miles, when they had to be reground. The flanges were now very thin, but they were allowed to run again as an experiment in flange wear. An additional wear of 8,000 miles was obtained before another turning. During all this time the other pair of wheels had never been out, and their flanges were wearing uniformly, although they were getting thin by this time. They were turned, after running 93,482 miles with a wear of 0.0105 inch per 1,000 miles. The stock removed in turning was 1.3 inch (0.0141 inch per 1,000 miles), or a total for wear and tool of 0.0173 inch per 1,000 miles. A large number of wheels have run 60,000 to 90,000 miles without removal, with the wear as low as 0.006 inch per 1,000 miles, and with an averages for ten pairs selected at random of 0.0109 inch service wear, and total wear and tool of 0.0122 inch per 1,000 miles. However, by deducting the first two pairs of wheels mentioned, an average of 57,888 miles

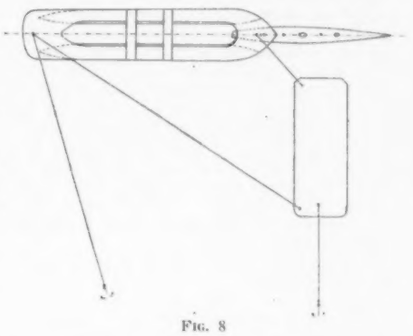


FIG. 8

is obtained, with an average wear of 0.00992 inch, and wear and tool of 0.0098 inch per 1,000 miles. This result, however, was attained by grinding instead of turning.

The Repin Refrigerating Process

IN the ordinary type of chemical or "affinity" refrigerating apparatus, the reduction of temperature is produced by the rapid evaporation of liquefied ammonia. The gaseous ammonia is recovered by means of its affinity for water, which absorbs it in great quantities. By heating the solution thus obtained, the ammonia is expelled into a cooled receiver, where it is liquefied by its own pressure. This apparatus possesses a serious defect which has gradually driven it out of use. The ammonia expelled from the solution carries with it about 25 per cent of water.

According to *La Nature*, Dr. Repin has devised a chemical refrigerating process which is free from this objection. The refrigerant is sulphur dioxide, which is easily liquefied and absorbs much heat in its evaporation. The absorbent is camphor, which takes up 30 per cent of sulphur dioxide, forming a very stable solution of low vapor tension, which, when heated, evolves all of its sulphur dioxide in gaseous form. The heated mixture, however, foams excessively, and the camphor is left in the melted form, in which it is unsuitable for further use as an absorbent.

Dr. Repin has remedied these defects by mixing with the camphor 20 per cent of naphtol. The only liquid thus obtained retains all the power of the camphor to absorb sulphur dioxide, which it disengages completely at a temperature below 212 deg. F. The pressure of the gas during the distillation does not exceed 5 or 6 atmospheres, and a temperature of 17½ deg. F. can be obtained. This method appears especially well adapted to economical refrigeration on a small scale, in laboratories and elsewhere.

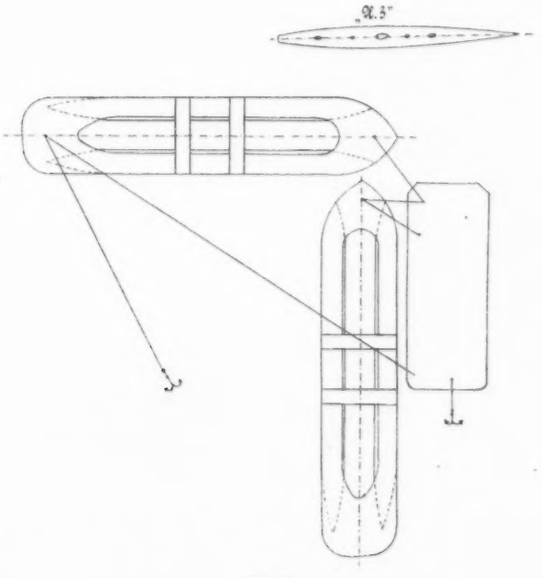


FIG. 7

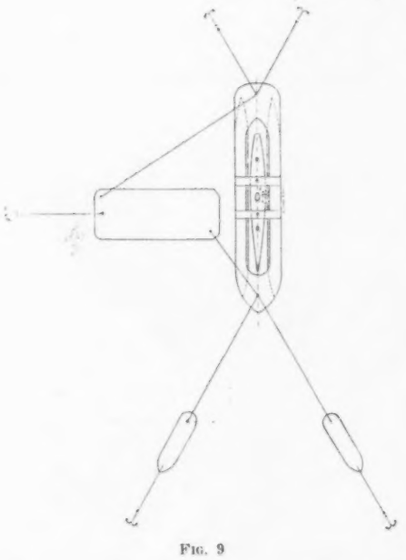


FIG. 9

The Light of Living Animals

The Structure of Photogenic Organs

By F. Alexander McDermott, Washington, D. C.

THE power of producing light in living tissues—the photogenic function—is a property widely distributed in the animal and vegetable kingdoms, especially in marine organisms. In general, the light produced by the various living photogenic forms is very similar in character, being in most cases confined to those radiations which have the highest illuminating effects, with the lowest actinic and thermal effects. The maximum brightness of the light given out by such organisms is usually at or about wave length 0.57 μ[1] in the yellow-green, where the light has an illuminating efficiency of practically 100 per cent. Moreover, the production of light in all cases where definite studies have been made, appears to be the result of the oxidation, in the presence of water, of some product of the life processes of the creature. But in spite of these general similarities, there are wide differences between different forms in the apparatus by means of which this production of light is effected. Many of the lower forms possess no definite organs for the function—the emission of light, like their sensitiveness to it, being a property of the cell as a whole. Among the higher forms also we find some in which the light is produced within special cellular masses having no very definite structure. Both of these cases may be classed as simple intracellular photogenicity. Still higher in the scale we find those forms in which the light is produced within definite organs, of more or less complicated structure—usually glandular—and in these the production may be either intracellular and intraglandular, or extracellular and intraglandular. In still other forms, the glands and secretions may both be luminous (intra- and extraglandular), and in still others the secretion of a non-luminous gland may be luminous, when the photogenicity becomes entirely extraglandular. An attempt will be made here to describe some of these peculiar variations of the photogenic function, and to give what is known of the structures used in its production.

Probably the simplest forms possessing the photogenic power are the luminous bacteria, of which there are a large number of species known. On account of their extremely small size, no definite organs for the production of light have been observed, but the luminosity appears to result from the oxidation of some product of the metabolism of the cell, and usually necessitates the presence of some mineral salt—notably sodium chloride—for its manifestation. Higher vegetable forms—fungi, mycelia, algæ, etc.—do exist, however, which do not appear to require the presence of mineral salts for the development of light, at least not in the same amount as the bacteria require sodium chloride or some similar compound, and which yet give a light not unlike that of the less highly organized forms. In these, however, no special photogenic organs have been shown to exist, and it seems not improbable that in the bacteria, fungi, and other luminous vegetable forms, the photogenicity is a property of the individual cells, inherent in them, and consisting of the oxidation of some portion of the cell constituents.

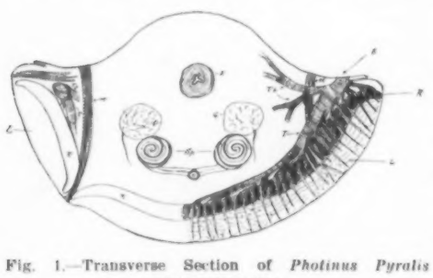


Fig. 1.—Transverse Section of *Photinus Pyralis* (Diagrammatic)

The right-hand half shows the arrangement and distribution of the tracheæ, while the left-hand half shows the modification of the luminous tissue at the point of attachment of the breathing muscles.

G, testes; I, intestine; L, true photogenic tissue; R, reflecting layer; S, spiracle or stigmatum; Sp, spiral organs (function uncertain); T, main tracheæ to photogenic organ; Tb, main respiratory tracheæ; M, muscle fibers.

Among those classes which constitute the lowest forms of organized matter, it becomes somewhat difficult to distinguish between those which should be classed as vegetables and those which belong to the animal kingdom. Many of the bacteria known to produce light are marine in origin, and with them may be grouped the numerous simple marine animal forms which also possess this power. *Noctiluca miliaris*, the *Pyrocystæ*, and many other animal forms of low organization possess no definite organs for the photogenic function. Under the microscope, however, the light in these forms is seen to proceed from a multitude of tiny points, and it may sometime be shown that these points of light are true luminous organs, having some more or less complex structure.

The higher we go in the scale of animal life, the more specialized and complex become the organs for the production of light. For instance, Pyrosoma, a Tunicate ascidian, shows the restriction of the phenomenon to certain portions of its constituent animalcules, and while but little of the structure has as yet been made out, these portions are doubtless definite photogenic organs. Panceri has estimated that in a Pyrosoma eight centimeters long there are 6,400 of these luminous organs, two to each of the constituent animacules. In the molluscs, insects, crustaceans, myriapods, cephalopods and fishes the photogenic organs show definite and characteristic structures. In all of these groups there are one or more species known which have complex organs for the production of light. In the different types and species, however, the structures of the photogenic organs vary considerably. Those of the sea-living organisms, for instance, as might be expected, differ widely from those of the air-breathing forms.

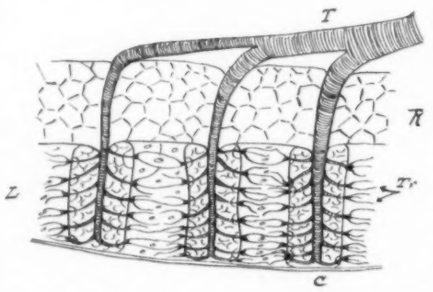


Fig. 2a.—Vertical Section of Photogenic Organ, Showing Trachea *T*, With Three Branches, Passing Through the Reflecting Layer *R* and the Photogenic Layer *L*, Surrounded by the Cylinders *C*, and Branching into Tracheoles *Tr*.

The luminous forms most familiar to the majority of us are the Lampyridæ—the fireflies, lightning-bugs, glow-worms, etc.—and upon these the bulk of the work on the structure of photogenic organs has been done. It is common knowledge that if a firefly is crushed and the luminous tissue exposed to the air, it glows; this suggests that the phenomenon is dependent on the presence of air, or some of the constituents thereof. This view is borne out by the structure of the photogenic organs of these insects. Perhaps a dozen different species of the Lampyridæ have been submitted to examination as to the structure of these organs, and in general the structures have been found to be the same; slight differences, mainly in the finer structures, have been described and illustrated, but for all practical purposes the photogenic organs of the different species of this family of insects may be regarded as substantially the same. Fig. 1 represents a diagrammatic cross-section through a Lampyrid at about the middle of the fifth abdominal segment; the particular species from which this is taken is *Photinus pyralis*, one of the commonest and most widely distributed varieties in the United States.

In this drawing, *G* is one of the testes, *I* is the intestine, *L* is the photogenic tissue proper, *R* is the reflecting layer, *S* is the spiracles or stigmatum, *Sp* are spiral organs connected with the reproductive systems, *T* are the main tracheæ and their branches leading to the photogenic-organ, *Tb* are the tracheæ leading to the other organs—the general respiratory system of the insect—and *M* the breathing muscles. The luminous organ consists of two layers, *R* and *L*. *R* is primarily a reflector, and consists mainly of a layer of guanine, or ammonium urate, or both, contained in polygonal cells; *L* consists of cells of irregular size and shape, and constitutes the true photogenic layer, in which the biologic oxidation and its consequent light production take place. The main tracheæ begin at the spiracles, just below which they divide from the breathing tracheæ, and continue downward and inward towards the middle of the ventral side of the abdominal cavity, continually throwing off branches, which again subdivide, and so the subdivision goes on to the fine tracheæ which plunge through the photogenic organ. The larger tracheæ all show the spiral-winding structure, and at least as far as the inner surface of the reflecting layer their interior is provided with fine, chitinous, hair-like projections, pointing inward. Both the layers *R* and *L* are penetrated almost perpendicularly by the tracheæ which supply the air to the finer tracheoles connecting them; these tracheæ are usually simple and nearly straight in their course through the reflecting and photogenic tissues, though forked and curved tracheæ in these layers are occasionally met with. Throughout their length through the photogenic layer, the tracheæ send out very fine branches, the tracheoles, which anastomose with the tracheoles from adjacent tracheæ, forming a network of fine passages around the cells of the photogenic tissue. These tracheoles are so small as to appear merely as lines, even under a powerful microscope. Each tracheæ, as it passes through the luminous layer, is surrounded by a cylindrical mass of cells of a character quite distinct from those of the true light-giving tissue, and under the microscope these cylinders show as non-luminous spots on the background of light in the living insect. Fig. 2 represents this finer structure, *a* in vertical and *b* in horizontal cross-section.

In the four American species of Lampyridæ which have been studied—*Photinus marginellus*, *P. pyralis*, *P. consanguineus*, and *Photuris pennsylvanica*, these structures have been found to be identical, and it is probable that they are very similar as regards their general character, in all species of this family. There are some slight differences in minor points even among the local species, however; for instance, in *Photuris* the thickness of the true photogenic tissue was found to be very much less than in *Photinus*, both actually and in proportion to the thickness of the reflecting layer, and the tracheæ seem to be a little more sparsely distributed through the luminous layer. This may have some relation to the fact which has often been observed that the light of *Photuris* is more greenish than that of *Photinus*.

While the Lampyridæ constitute the largest class of light-emitting insects, one other family of Coleoptera includes several brightly luminous species—the group *Pyrophorini* of the family Elateridæ, the best known of which are the Cuban cucuyo, *Pyrophorus noctilucus*, and the smaller elaterid firefly of our Southern States, *P. Physoderus*. The former has been the most studied, and a few words regarding it will not be amiss. The cucuyo is a large, hard-shelled "snapping-beetle," or elater, and emits light from three photogenic organs, two on the dorsal side of the thorax, and the third on the ventral side at the forward end of the abdomen. The emitted light is very similar to that of the Lampyridæ in quality, but differs in that it is continuous, varying in intensity but not being entirely extinguished under ordinary circumstances. In structure, the light-emitting organs are very like those of the Lampyridæ. Under the outer chitin (which is thicker and harder than in the Lampyridæ) is a layer of true photogenic tissue, and back of this is a reflecting layer, the whole being

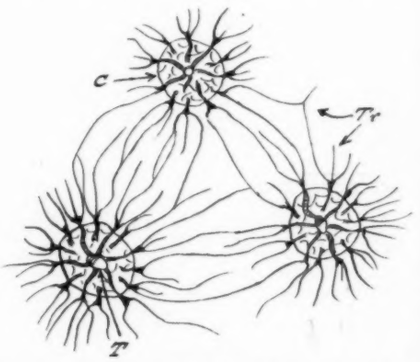


Fig. 2b.—Cross Section (Horizontal) Through Three of the Vertical Tracheæ Within the True Photogenic Tissue, Showing Cylinders *C* and Tracheoles *Tr*.

[1] μ = 0.001 mm. = 0.00004 inch.

supplied with air through a system of tracheæ connecting the main respiratory system of the insects, in very much the same way as the more common insects.

Still another group of luminous insects should not be passed without mention, although regrettably no studies have been made as to the structure of their photogenic organs. This group is the *Phengodini*, of which a few species are known in the United States. All species appear to be rare. In this remarkable group the females, in their adult stage, retain the form of larvæ, while the adult males are provided with powerful wings, though with only short elytra, and have very large eyes. The larviform

Fig. 3a.—Section of Photogenic Organ of Histioteuthis Rüppelli, a Cephalopod, After Hoyle.

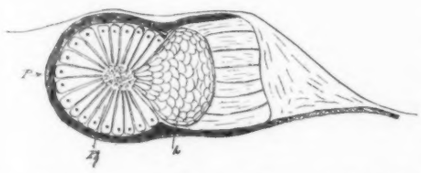


Fig. 3b.—Section of Photogenic Organ of *Chauliodus* Barbatus, a Deep-sea Fish, After von Lenderfeld.

L, lens; M, external mirror; P, pigment layer; Ph, photogenic body; R, internal reflector.

females are very luminous, there being two or three luminous organs at each segment, and sometimes additional organs at the head. More remarkable yet, the light emitted from the organs of the body is different from that emitted from the organ at the head, the former being greenish or bluish, and the latter reddish. These insects are very beautiful, though but rarely seen. The males of some tropical species are said to possess photogenicity, but no light has been observed from the males of our species.

Of the other insects which have been reported to be luminous, but little can be said. No confirmation has been found obtainable of the statement of Latrielle that the brilliant *Buprestis ocellata* of India is luminous; the spots to which luminosity is attributed are upon the elytra, and if they are realy luminous it is a very anomalous case. So far as the Fulgoridæ, the lantern-flies, are concerned, it seems to have been pretty definitely shown that they are not photogenic under ordinary circumstances. It would be interesting to try Waxasé's test, by placing the supposedly luminous beaks of these insects in dilute ammonia, when, according to this author, if they are really photogenic organs, light should be evolved. The light of the luminous midgets, will-o'-the-wisps, ignes fatui, etc., appears to be due to the infection of non-photogenic insects with bacteria having this power, and is therefore not properly classed with that of the true photogenic insects.

Next to the luminous insects, the most brilliant luminous forms seem to be the cephalopods—the cuttlefishes. Prof. C. Chun and Prof. W. E. Hoyle have made interesting studies of these organs, but the

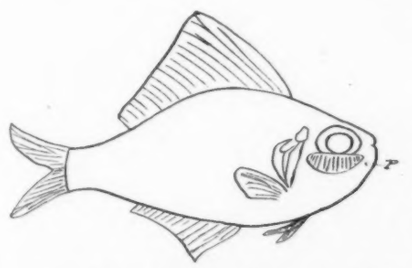


Fig. 4a.—*Photoblepharon Palpebratus*, After Steche, Showing Location of Large Photogenic Organ *P*.

actual number of times at which they have been observed to emit light is surprisingly small. With the Cephalopoda we may consider certain of the luminous fish, many of them caught at great depths in the sea, since some of their photogenic organs are not unlike those of the cuttlefishes. The organs which we will first describe are those classed by Prof. Hoyle as "non-glandular." In both the fish and the cephalopods these organs present a typical "search-light" structure. The organs are inclosed within protuberances on the creature's surface, and each consists of a layer of dark pigment cells *P*, a reflector *R*, a photogenic mass *Ph*, and a lens *L*. Fig. 3a, adapted from Hoyle, shows this structure as seen in a cephalopod, and *b* shows the same type of organ from a deep-sea fish, adapted from Von Lendenfeld. In the cephalopods these organs have been said to emit very brilliant lights of various tones of red, yellow and blue, as well as white and greenish; in the fish the emitted light appears to be of a pale greenish color, not unlike that of some fireflies. The photogenic tissue proper, in the luminous organs of this class, is richly supplied with nerves and blood vessels, and it is probable that in them, as in the Lampyridæ, the photogenic process is one of oxidation, the oxygen, however, being supplied to the tissue through the blood of the animal instead of being directly applied in the gaseous state from the air.

An interesting point to be noted here is the location of these photogenic organs in marine forms. Hoyle mentions that in the Cephalopods the great majority of the organs on the body are directed downward; in this group of animals, however, many species are provided with photogenic organs situated immediately upon the eyeball, a situation which leaves but little doubt of its usefulness to the bearer. It has also been noticed that in the luminous fish the photogenic organs frequently are arranged so as to present the appearance of two or more parallel rows of bright points, when the creature is viewed from below. The fishes also very frequently have luminous appendages, barbels, etc., where the photogenicity undoubtedly has an alluring significance, and further, while as yet no true fish has been found with photogenic organs situated upon the eyeball, as in the Cephalopods, a number of fish have been observed to have such organs situated in close proximity to the eye, in such a way as to undoubtedly assist the vision of the creature.

Another different type of photogenic organ is also found in a few Cephalopods, and in a number of fish; this is the strictly glandular type of organ in which the luminous process is restricted to the interior of the organs. Dr. Otto Steche has made some interesting observations upon the structure of these organs in the fishes known as *Anomalops katoptron* and *Photoblepharon palpebratus*. The photogenic organs of these species are the largest, both actually and in proportion to the size of the fish, so far observed. The creatures themselves are very small—8 to 10 centimeters long—and the luminous organs occupy an area immediately below the eye-socket. Dr. Steche states that the luminous tissue proper is a typical gland. Although the process of light-production by these organs must be very different from that in the organs of the Lampyridæ, some of the structures remind one very much of those in the insect organs. Figs. 4*a* and *b*, taken from Steche's paper, show the location of the light-organ, and a section of a portion of the gland, respectively.

Another interesting type of luminous organ is present in at least one species of Cephalopod, in the mollusc *Pholas dactylus*, and in certain myriapods. These are organs that secrete a mucus, which is discharged into the air or water, and there becomes luminous through oxidation. Organs of this type are of course true glands, and though their structure in different creatures need not be the same, their functions are very similar. Dubois has made a very extensive study of the glands of *Pholas*, the interesting luminous bivalve that has formed the basis of the oldest scientific observations of biophotogenesis on record. The structure is not distinctive, being typically glandular, but a reproduction of one of Panceri's drawings, Fig. 5, showing the location of the organs, is given herewith.

It is a little difficult, in view of the wide diversity of the structures of the photogenic organs and the variations in the modes of light production, to ascribe to the photogenic function of all forms, a common origin. In the majority of cases the photogenic tissues appear to be a derivative or extension of the adipose tissues of the organism. It is certain that in a considerable number of forms of very different habitude and structure, Nature has reached the point of the production of "the cheapest form of light" by very different methods—that is, living creatures belonging to widely separated groups and families, and even orders and kingdoms, may produce light of very similar quality and spectral constitution, through the agency of very different structures. Surely, among these various methods there should be at least one which would offer possibilities for artificial reproduction. But for the realization of this we must as yet look to the future.

Textile Manufacturing

IN the manufacture of textile and other products, such as wool, silk, paper or fiber, in order to obtain a good quality and avoid too much waste of material, it is required to resort to methods which are very objectionable from the standpoint of hygiene. For instance, in the preparation of wood threads, these become electrified, and this causes the fibers to spread out, and a considerable amount is detached from the main body, so that a good percentage of waste is the result, seeing that the material which falls off is of less value. Besides, the thread is of irregular size and is liable to break. The quantity of thread is lessened and more work is needed for the same amount of thread. A wetting process is generally used in factories to prevent the thread from becoming electrified, but this is bad for the health, as no air is admitted and the windows are always closed, and

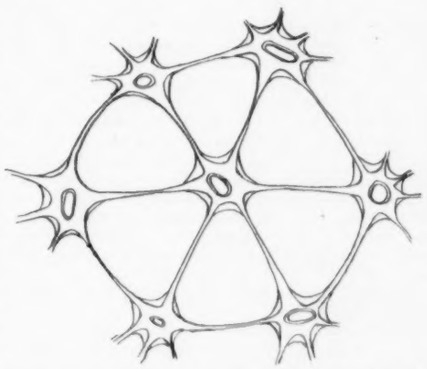


Fig. 4b.—A Portion of the Glandular Structure of the Photogenic Organ of *Anomalops Katoptron*, After Steche.

besides, the rooms are much overheated. The excess of dampness is also a disadvantage in that it causes the products to stick to the machines, and this is another source of waste. Electrical methods have been tried, such as distributing an electric charge along the machines by insulated conductors so as to annul the static charge. Induction coils or electrostatic machines were used, but without success for various reasons. High-tension alternating currents are too dangerous to use here. New experiments were made in France by M. Paillet, and in an account presented to the Académie des Sciences he states that he secured good results by using currents of high frequency and high tension such as are used in electromedical work after the researches of Professor D'Arsonval and others, and more recently in wireless telegraphy. Such currents have no danger, and much power can be used without any harm. Condensers are supplied with high tension current from a transformer, so as to give the oscillatory discharge. Wires are stretched along the machines and near the textile matter, and have small metal brushes so as to direct the electric discharge where it is needed. The results show that the threads were stronger and the breaking strain is from 7 to 15 per cent higher. In some cases this reached 22 per cent. The threads are more elastic, about 19 per cent., and the waste is lessened about 23 per cent. On low-grade wools where the waste is high this is lessened even by 28 per cent Better hygiene can be observed, as air in the rooms

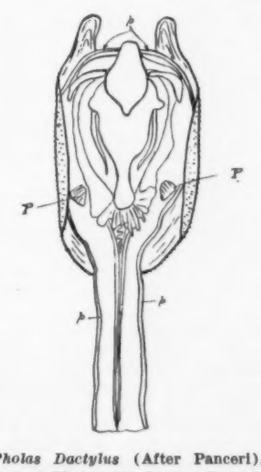


Fig. 5.—*Pholas Dactylus* (After Panceri), Showing Location of Photogenic Organs *P*, and Parts Ordinarily Luminous From the Mucus Secreted by the Organs *p*.

need not be as damp and the heat is less. In this way the work is carried on under much better conditions in every way.

Dynamics of the Flying Machine*

Some of the Dangers of Mechanical Flight.

By James S. Stephens, M. W. S. E.

IT should be understood that while it is the writer's belief that this paper contains a plausible theory to account for some of the dangers of mechanical flight, he hopes it will be chiefly instrumental in interesting some of the engineering profession who have heretofore given the matter little serious thought or attention; also that it may promote a discussion of some of the phases of the question and thus bring out information that may assist in the advancement of the art.

The writer is aware of the fact that some of the statements and deductions made herein, when considered from certain viewpoints, are not in accord with the laws of dynamics as commonly accepted, but this, in his opinion, should aid rather than prevent a liberal discussion, as some of the peculiar conditions involved may cause the majority of those who consider the matter to at least question the exactness of some of the laws of dynamics as commonly understood, when applied to the operation of a flying machine.

During the past decade, public opinion of the flying machine may be said to have passed through three stages.

First, viewed as ridiculous, then as sublime, and now, on account of the great number of fatal accidents which have occurred, as tragical.

All of these accidents have had some specific cause, and numerous explanations and theories have been offered to account for them. Unfortunately the man who would have best been able to offer a satisfactory solution has in practically every case lost his life.

Theories have been advanced by some of the aviators blaming the so-called *Swiss cheese* sky and *holes in the air* for many of these accidents.

It is generally admitted that there are many varying currents in the air, and that these changes of speed and direction in the motion of the air are undoubtedly greater near the surface of the earth than they are higher up, and while some of the difficulties of flying are chargeable to this cause, it has, the writer believes, been blamed for a great deal more than it is accountable for. Such variations as do occur in the trend of the wind or air currents are not sufficiently abrupt to make flying extra hazardous from that cause alone.

Once a machine is off the ground, it would be immaterial whether the wind was blowing steadily in one direction 1 mile or 100 miles an hour, if it were not for the fact that it is necessary to give due consideration to the laws of inertia, acceleration, retardation, momentum, centrifugal force and gravity in their proper relation to the speed of the machine, both relative to the air and relative to the earth.

The writer will not undertake to discuss in mathematical detail these various factors governing the conditions of mechanical flight, but will confine himself to some simple illustrations which he believes will provide an explanation of the causes of many of the aeroplane accidents which have lately happened.

In still air a flying machine, in maneuvering in a horizontal plane, would have to accommodate itself to practically the same conditions as a vehicle on the ground. In starting up, increasing or decreasing the speed, the inertia of the weight of the machine must be overcome, thus introducing the elements of time and power. In turning, some positive resistance, such as banking the machine, must be depended upon to counteract the centrifugal or tangential forces.

All of the men who have flown these machines have learned to do so in comparatively still air, and have been thoroughly familiar with the conditional requirements just referred to, as a result of their experience with vehicles running on the ground.

Flying in a wind, the writer believes, introduces the effect of some of Nature's laws in a way that up to the present time has not been fully appreciated, and therefore has not had the consideration which is due.

To illustrate, imagine a machine flying at the rate of 40 miles an hour, which is in round numbers 60 feet per second, directly against a wind blowing at the same speed. While such a machine would maintain itself in the air just as surely and safely as if it were flying on a calm day and covering a distance of 40 miles an hour as measured on the earth's surface, it would in fact actually be standing still, in so far as its relative position to the earth is concerned, and the entire output of its engine would be expended in supporting it against the action of gravity and preventing it from drifting backward in the wind.

Now, for the sake of the illustration, consider what would happen if the 40-mile wind could be suddenly stopped. The machine, having no initial velocity or momentum, could get no support from the air until it could acquire a sufficiently high relative velocity. This, on account of inertia, and the limited power available, requires time, and during such time-interval the machine must fall. While the abrupt stopping of a 40-mile wind is not possible, a somewhat analogous condition may be brought about by an abrupt turning of the machine when it is stationary relative to the earth through flying against a high wind as above mentioned.

Under the most favorable conditions, it would take considerable time to bring a machine weighing about 1,200 pounds from a standing position up to a speed of 60 feet per second, or double this speed, as the writer will endeavor to show may be necessary under certain practical conditions.

The following is quoted from *Aircraft*, the December issue, describing the flight of Johnstone and Hoxsey at the Belmont Park international aviation meet, both of whom have since lost their lives as martyrs to the cause of progress. "They faced the wind coming in from the ocean, and as they went higher their speed in relation to the ground rapidly diminished as that of the air they were meeting became greater. Soon they appeared to be standing still, the velocity of the wind being just even to theirs (about 38 miles), and then, as they went higher, they started to lose ground and the higher they went the faster they went backwards. Close together they appeared like two great kites on a string—a string being slowly paid out."

How great a wind Johnstone faced at his maximum altitude of 8,500 feet no one can say, but with his machine going close on to 40 miles an hour, he was blown backward some 40 miles in the course of less than two hours, and 75 miles an hour is not an exaggerated estimate of the maximum velocity of the wind met by him.

Brookins, Johnstone, and Hoxsey, on Wright machines, have made complete circles in the air in about six seconds. Let us suppose one of them had undertaken to make such a turn when flying against a head wind; a quarter of a turn would be made in less than two seconds, with the result that, whereas the machine before the turn had the necessary supporting power to maintain it in the air, in less than two seconds of time it would have turned around a quarter of a turn in the air, and with respect to its relative position to the earth, would have practically turned upon its own center, and have begun to drift sideways, having practically lost all of its sustaining power; it had no initial forward motion when commencing to make the turn, the time allowed not being sufficient to acquire the necessary acceleration, and the power available not being great enough.

Should he be able to get his machine around a full half turn, which he might be able to do in three seconds, the machine, even though assisted by all the power of its engine, and the effect of the wind in the direction it had turned, could not in that limited time have gotten up sufficient headway against its own inertia so as to be moving as fast as the wind itself, and the wind would actually be blowing from behind and aiding gravity in forcing the machine downward. It seems hardly probable that under such conditions it would be possible for the operator to again right the machine, even though it were falling head first, especially if he was not aware of the actual cause of the trouble.

As a matter of fact, a machine under such conditions as above outlined would, in so far as the forces of gravity and inertia are concerned, have to start from a standstill and acquire a velocity of 80 miles per hour relative to the earth before again obtaining its normal supporting power of 40 miles per hour relative to the air in which it would be flying.

A further complication would be the fact that once commencing a turn under the conditions above stated, the machine would have a tendency to turn practically on its own center, and having thus acquired an initial rotary motion with little forward motion in the same plane, it would be much harder to check or reverse the turn. Any effort which might be made by the operator would probably be such as would result in just the reverse to that intended, as the conditions of support would for the time be reversed.

The support of a flying machine in the air depends upon a nice adjustment of the speed relative to the air, its surface and power, as opposed to the action of gravity. The power may be so applied when flying as to store up within the machine dynamic force which would be the product of its speed relative to the earth and its weight, or simply to overcome the static force caused by gravity, if the machine were flying against a wind blowing at the same speed required for sustention. In fact, if the machine were flying against a wind blowing relative to the earth at greater speed than the speed of the machine through the air, it would then have stored up within itself dynamic force acting in the opposite direction to which the machine would be actually moving through the air.

It seems evident that a flying machine may be turned very quickly and may, on account of the small frictional hold it has upon the air, and due to momentum, or centrifugal force, skid a considerable distance in making a turn, unless the resistance available by banking the machine is adjusted very nicely to the relative forces brought about by the speed of the machine.

It is the writer's belief that such quick turns, if made in a wind, are extremely dangerous and are responsible for at least some of the fatal accidents which have occurred.

Prof. Langley, the writer believes, was the first to compare the flight of an aeroplane to a skater passing rapidly over thin ice, which would sustain him safely so long as he maintained sufficient speed to distribute his weight over a sufficient area. Let us go a little further with this illustration; we know that the skater might turn his body around while passing swiftly over such thin ice, and still continue on in safety, but should he check his speed and endeavor to reverse the direction of motion, he would surely break through. So with a flying machine; if turned too quickly, its momentum would tend to carry it along in the direction in which it had been flying until it reached a critical position without sufficient support from speed in the direction it had been turned.

Safety in either case could be assured only by making a long turn that would meet the requirements of time, weight, and surface; and, while the skater might turn on his own center, skating either face forward or backward, without affecting his safety so long as he maintained his speed, the flying machine must of necessity at all times present its front directly toward its direction of motion, and at the same time maintain its proper angle of incidence and forward speed relative to the air to prevent its falling.

This essential condition that the machine must be moving at its full speed relative to the air and in the direction it has turned, irrespective of the speed of the wind or the relative speed of the machine to the earth, and the fact that such changes in direction when flying in a wind may bring about or require rapid changes in the actual velocity of the machine itself, so that at all times it may have a normal speed relative to the wind, is, the writer believes, responsible for conditions which we have not had to consider in other methods of transportation prior to the advent of the flying machine.

It is believed that a greater power is required to get a machine off of the ground than that necessary to maintain it in the air in horizontal flight.

If making a flight in still air, the machine might start in any direction on level ground. The power required would be that which would be necessary to overcome the head resistance of the air, the frictional resistance of the air, the action of gravity, and the inertia of the weight of the machine in bringing it up to the speed necessary for sustention, in a given time. After attaining this speed, that portion of the power required for overcoming inertia would remain in the machine as kinetic energy, and when flying in still air would remain constant irrespective of the direction in which the machine might be flying.

If a machine were started from a stationary position on the ground against a head wind blowing at a speed equal to that necessary for the support of the machine, no power would be required to overcome the inertia of the machine in a horizontal plane; it would maintain its relative position to the earth; and if it were possible for the wind to instantly stop blowing, the machine would fall during the time necessary to accelerate the machine up to a speed necessary for support.

If a machine were started from a stationary position on the ground, moving in the same direction with a wind blowing at a speed equal to that necessary for the support of the machine, it may be assumed that, if sufficient time is allowed, the force of the wind will accelerate the speed of the machine up to the speed of the wind, but from this time until the machine obtains a speed necessary for support greater than the speed of the wind, the same elements of resistance will have to be overcome as in starting from the

* Read before the Western Society of Engineers.

ground in still air, including the power and time necessary to overcome the inertia of the machine.

The above statements, the writer believes, demonstrate the fact that in flying in a wind and making a turn, the necessity for quick changes in the actual velocity of the machine, required to accommodate the speed of the machine to the speed of the wind when the direction of the machine is changed, may be such as to cause the machine to fall for want of sufficient surplus power to meet such variable conditions, or on account of not allowing sufficient time for the small amount of power available to meet the requirements of changes in the actual velocity of the machine.

In flying in a wind it would seem as if there must always be a variable resistance or momentum to be considered when making a turn; that this variable will be proportionate to the speed of the wind, and must be provided for, when turning, by the allowance of ample time for increase or decrease of the actual speed of the machine so that it may at all times maintain its normal speed relative to the air. Also that, in making such adjustments of time and speed, the weight of the machine, the normal speed, the amount of surface, and the surplus power available will all have to receive due consideration—in the hands of an expert operator who has become thoroughly familiar with these conditions and their relative values—if safety in flight is to be attained.

A flying machine cannot, without risk of falling, be turned in its course through the air without allowing the necessary time relative to the power and weight to overcome its inertia and maintain its speed in the direction it has turned.

For the sake of argument, consider what would actually happen to a flying machine weighing 1,000 pounds moving through the air at the rate of 60 feet per second, or 40 miles per hour, and making a complete turn in the air in six seconds, while the wind was blowing at a speed of 40 miles per hour, the turn to commence when the machine was flying against the wind and practically standing still relative to the earth. In making such a turn in still air, the machine would traverse a true circle about 360 feet in circumference, both in the air and relative to the earth, commencing and completing the turn with the normal speed necessary for sustention, 60 feet per second in the air and relative to the earth's surface at all points of the turn.

In making a turn in the air with the wind blowing 40 miles per hour, the machine would, if it were not for the effect of inertia, traverse a true circle relative to the air just as when turning in still air; but relative to the earth, it would move in the direction in which the wind was blowing 60 feet per second. But on account of inertia, in making such a complete turn the weight of the machine, 1,000 pounds, would have to be accelerated from a standing position to a speed of 120 feet per second in the first three seconds of the turn, and retarded from this speed to a full stop in the last three seconds of the turn.

As a matter of fact, a flying machine may be turned around in about six seconds, and with comparative safety, in still air, but to make such a turn and at the same time increase the speed of 1,000 pounds weight to 120 feet per second, and again retard it the same amount in six seconds, is beyond the power available for acceleration or the strength of the machine to act in retardation, especially if we consider the fact that the power available for acceleration would be very small, practically all of the power being actually necessary to support the machine in the air. The amount of power available over and above that required for sustention may be approximated by the ability of the machine to rise. For instance, if a machine weighing 1,000 pounds were capable of rising 100 feet per minute, this would indicate that it had 3 horse-power or 100,000 foot pounds per minute of surplus power above that required to maintain speed of sustention. Three seconds is one-twentieth of a minute, so that we would have 5,000 foot pounds available for three seconds to increase the velocity of 1,000 pounds weight to 120 feet per second. It would take about 140,000 foot pounds to do this in three seconds, or about a minute and a half to accelerate 1,000 pounds weight with the energy available, 5,000 foot pounds.

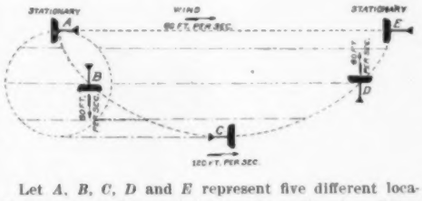
These figures are merely approximations made to illustrate the conditions involved.

The wind would assist in acceleration on the first half of the turn, and the resistance of the air to forward motion would help decrease the time necessary on the last half of the turn. This would materially decrease the time required for the complete turn. The arbitrary conditions mentioned herein are used for illustration only. The actual time in which a safe turn may be made in the air may be closely estimated, if we have the weight of the machine, know how much surplus power it has, know the speed of the machine relative to the air, and the speed of the wind.

The product of these factors would be varied somewhat by the area of the surface of the machine, the form of the machine, and the ability of the operator to control it to the best advantage.

A diagram may be made, graphically showing any combination of the conditions governing the turning of a flying machine in the air.

To illustrate the conditions above mentioned, the following method is suggested:



Let *A*, *B*, *C*, *D* and *E* represent five different locations of a machine relative to the earth when flying 40 miles per hour against a wind blowing 40 miles per hour, and making a complete turn, the dotted line representing the course of the machine relative to the earth in making the turn, and *A*, *B*, *C*, *D* and *E* relative positions of the machine during the turn. The machine would be standing still at *A*; it would have turned a quarter of a turn and increased its speed to 60 feet per second at *B*; half a turn and a total acceleration of 120 feet per second at *C*; three-fourths of a turn and retarded 60 feet per second at *D*, and a full turn to a stationary position relative to the earth at *E*. It would therefore appear that such a turn could not be made safely in much less than a minute and a half under conditions previously stated.

If the machine were flying in still air, it would have completed a true circle both relative to the air and earth, and location *E* would coincide with location *A* on one side of the circle. This it might do safely in a few seconds of time.

Such a diagram might be made to show time, weight, distance, speeds, etc., and their relation to each other for any specific construction of machine, and in this way establish limiting conditions which would be a guide to the aviator in governing the movements of the machine, so as to be able at all times to keep it under safe control.

It is believed that some of the accidents referred to have been due to a combination of the above named causes, and the failure of the aviator to appreciate their varying influence as compared to his speed through the air and his relative speed over the earth due to the speed of the wind. It is only when quite near the earth that the relative speed of the machine may be judged of; when higher up, the aviator's attention is given to necessary adjustments to meet the changing conditions in the air.

On approaching the ground, he has no way of determining the direction or speed of the wind except by noting some object such as smoke or a flag, or by first flying in a circle near the earth and noting the amount and direction of the side drift of the machine. And it must be admitted that to do this even approximately must require a highly cultivated sense of speed and direction. Any speed indicator placed upon a machine can only show the speed through the air. Nevertheless, such an instrument is of the highest importance as a guide, to limit speed in gliding and to maintain necessary speed for sustention. It is quite possible that accidents have occurred on account of lack of knowledge of these relative speeds.

This paper has been presented with a belief that it will give rise to a discussion of the subject which may lead to further investigation, and perhaps develop a greater interest in the possibilities of the flying machine from the standpoint of the engineer.

The writer has long been interested in this subject and determined about a year ago to commence the construction of an experimental machine, with a view to in some measure safeguard the operator by devising a construction which will, he believes, have a large margin of natural inherent stability in the air.

Before commencing this constructon, he had become thoroughly convinced that a machine could be built to meet the following requirements, which it is believed are fundamentally essential to safety in flight:

1st. That the machine should be designed so that without manual control, it will automatically assume and maintain a straight horizontal line of flight when operated under power, and a proper minimum gliding angle forward when the power is shut off.

2nd. It must at all times automatically maintain its transverse stability when in flight, or when gliding without attention of the operator, or the intervention of intermediatory mechanically operated devices.

3rd. It must be capable of being positively controlled by the operator by a single simple controlling member to accomplish all of the operations of steering in any direction or of changing the lateral inclination of the machine to meet unusual requirements which may be met with in flying or brought about by the operator in steering.

4th. Such a machine should be built so as to have the same factor of safety relative to the strains involved in actual flying conditions as would be allowed for any other refined construction, upon which it is intended to carry the risk of human life.

These requirements have been stated simply to indicate the line of thought which has led up to a belief that some combination of the conditions as outlined in this paper have been responsible for a number of the fatal accidents with flying machines.

Acrobatic stunts and thrillers involving quick turns have been accomplished with apparent safety by competent aviators in still air. To attempt such demonstrations in a strong wind, whether it be blowing steadily or not, before we know definitely about all the various factors involved in safety in flight, seems to be an endeavor to beat some of the well-known laws of the resistance of weight to a change of motion, and likely to prove suicidal for the experimenter.

Canada's Asbestos Industry

CANADA produces 82 per cent of the world's supply of asbestos. The companies operating asbestos quarries and factories in the Dominion are capitalized at $24,290,000. In 1880 only 380 tons of asbestos were produced, valued at $24,700; whereas in 1909, the production amounted to 63,300 tons, valued at $2,300,000. In 1909, 3,000 men were employed in the asbestos industry, and received wages amounting to $1,350,000. These facts and much valuable technical information of practical value to the general public are contained in a finely printed and well illustrated volume of 316 pages, just issued by the Mines Branch of the Department of Mines, Ottawa. This valuable addition to the series of monogaphs being issued under the direction of Dr. Haanel, was written by Fritz Cirkel, M.E., and treats the subject of asbestos from every viewpoint: history, geology, peculiarities of Canadian occurrences, quarrying and milling, together with statistics, cost of extraction, its occurrence in foreign countries, and its practical application in the arts and manufactures. To give an idea of the enormous reserves in some of the asbestos deposits, Mr. Cirkel mentions the case of one, the Blake Lake quarries, Quebec, where there are some 45,000,000 tons of asbestos rock in sight. The author goes fully into the discussion of foreign asbestos occurrences, and considers Russia the only real rival as regards extent of asbestos resources. But inasmuch as the Russians are heavily handicapped by the excessive cost of transportation—$35 to $40 per ton to London—serious competition is not feared in the leading markets of the world. Dealing with the practical application of asbestos, Mr. Cirkel lays special emphasis on the prospective increased use of asbestos in the manufacture of slate. He says, on page 246:

"It will not be long before the asbestos slate or shingle business, which is just commencing to be felt, will push its way more and more to the front. Indeed it is not too much to say that the time is not far distant when fully 75 per cent of all asbestos produced in the world will be used in the manufacture of asbestos slate and shingles. The asbestos slate business is only four years old, but during that short space of time the demand for this article has increased to such an extent that factories for this purpose are being established all over the world."

The report covers over three hundred pages, contains 66 photo-engravings, 88 drawings, and two maps of the Quebec asbestos districts. It is one of the handsomest, practical, technical reports that has been issued by the Dominion government.

G. O. CASES, an English engineer, has suggested a novel type of reinforced concrete, in which wooden beams and laths take the place of iron rods and wires. The new material, which its inventor calls ligno-concrete, is intended as a substitute, not for ferro-concrete in general, but chiefly for wood as employed in the construction of roofs, footways, posts, etc. The wooden parts acts as traction members, and the concrete as a compression member.

It has been demonstrated by many tests that ligno-concrete is as strong as ferro-concrete when the wooden beams of the former have a cross-section which makes them as strong as the steel bars of the latter. The tractile strength of steel is eight or nine times that of wood, but steel is ten to fifteen times as costly as timber. Hence ligno-concrete, if it proves durable, may advantageously be substituted for ferro-concrete in many cases. The question of durability can be decided only by time and experience, but the many known instances of the permanence of wood protected by cement indicate that the decision will be favorable.

New Researches on Quartz Lamps

Leblanc's Experiments

As the result of a series of researches made at Paris by M. Maurice Leblanc upon the properties of quartz mercury vapor lamps, he has succeeded in constructing a lamp which gives a much greater economy than the usual mercury lamp, and at the same time he has greatly improved the color of the light so that it approaches the quality of "white light." At the same time the power consumption has been greatly reduced, amounting to only 0.25 to 0.30 watts per candle-power, a figure hitherto attained only by flaming arc lamps, which, however, have many disadvantages, such as rapid wear of the carbons, difficult regulation and necessity of frequently cleaning the globes. The new quartz lamp will burn for 1,000 hours, and involves no continuous consumption of perishable material. In point of running expense, it appears, therefore, to be the most economical lamp existing, though the first cost of manufacturing the quartz lamp is of course high. M. Leblanc gives the following account of his researches:

In the mercury vapor lamp, the amount of illumination which is produced for a certain given power depends upon the pressure of the mercury vapor in the tube. This relation is quite variable, however. For the ordinary mercury lamps in which the pressure is about 0.04 inch of mercury, the ratio is about 0.36 watt per candle-power, and this is the best result which can be obtained with an arc in a glass tube. It would be a great advantage to increase the pressure of the mercury vapor. This can readily be done by working the lamp at a higher temperature—for instance, by preventing the cooling of the walls of the lamp. But at such temperatures the glass would melt; so that in the case of a glass tube lamp a limit is soon reached beyond which the yield in light per unit cannot be raised by working at increased temperature. The problem is solved, however, by using a quartz tube for the lamp. This material is much more difficult to shape in the form required than glass, and thus causes some extra expense, but the resulting economy in running cost is very great. This will be noticed from the fact that at pressures of about 1 atmosphere we have but 0.25 watt per candle-power, as compared with the above quoted figure, and thus we use much less power for the same light. This high temperature has also the advantage of greatly improving the color of the light, which acquires a yellowish hue analogous to what certain flaming arc lamps give, and is rendered more agreeable to the eye.

It is well known that the quartz mercury vapor lamp gives off powerful ultra-violet rays, which are stopped entirely by the glass tube in the case of the ordinary vapor lamp. Such rays would be dangerous to the eyes, but by using a glass globe they can be quite cut off. The use of quartz for the new lamp gave rise to a number of difficulties, such as, for instance, the problem of sealing the conducting wire in through the tube. So long as glass tubes were used there was no trouble in sealing a platinum wire through the glass, for as the expansion of this metal with temperature takes place at very nearly the same rate as that of glass, the joint always holds good. But with quartz the matter is quite different, seeing that the expansion rate of quartz is very low and is about eight times less than that of platinum. Should we seal in a platinum wire, the joint would soon give way, owing to the very unequal expansion. An alloy, however, is known which also has a very small coefficient of expansion—namely, the nickel steel made by M. C. Guillaume of Paris, and known as "invar." It is valuable for many purposes, owing to its small expansion when heated or cooled, and is used for standard measures, clock pendulums, etc. It therefore comes in very well to match the low expansion of quartz. However, the "invar" alloy is a forged metal, which loses its characteristic properties when brought to a red heat. It cannot, therefore, be sealed into the glass, but instead is inserted by a ground joint like a glass bottle stopper, so that a relatively tight joint is obtained. As, however, there will always be slight leaks in such a joint, a mercury filling is put around it and the mercury is held in place by a solid cement covering (Fig. 1).

Another difficulty arises from the fact that in the mercury arc the fall of electric potential at the surface of the anode is greater than at the cathode surface, and thus the anode is always hotter than the cathode. For this reason there is a gradual transportation of all the mercury of the anode towards the cathode. At first sight it would seem that the simplest plan to avoid the accumulation of mercury at the colder electrode would be to place this at a higher level than the other. When the mercury accumulates, it would overflow, and would fall back into the lower electrode. But in the quartz lamp this movement of the liquid mercury would have the effect of putting out the arc, for the reason that the relatively cold mercury of the electrode, when passing into the very hot arc tube, would be partly vaporized and there would be a sudden rise in the pressure inside the tube, causing the extinction of the arc. A compensating method had to be found which would automatically hold the

Fig. 1.—Method of Inserting the Invar Electrode, with Mercury Seal

level of the two electrodes constant in spite of their difference of temperature. This M. Leblanc has succeeded in doing. He connects the negative electrode with the vapor tube proper by a conical tube whose top is near the arc tube (Fig. 2). Should the mercury accumulate at the negative electrode, the level rises in the conical tube. The arc now starts from a smaller surface of mercury, which is therefore heated more strongly, giving rise to an increased evaporation. Thus the mercury tends to be driven off by the evaporation. Should the level be lowered

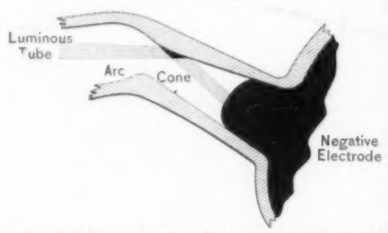


Fig. 2.—Arrangement for Automatically Controlling the Distillation of Mercury from the Anode

in the conical tube, the reverse effect takes place, and thus prevents the mercury from accumulating at the positive electrode. In practice, by designing the conical tube properly, we secure an automatic action, and this is found to work very well.

Another point which requires attention is to assure proper cooling of the tube in order that the pressure of the vapor should not rise too high. This cooling is effected by surrounding the electrodes by a set of copper cooling wings (Fig. 3), which act as a radiator

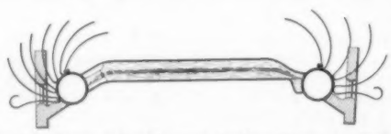


Fig. 3.—Mercury Lamp with Cooling Vanes or Wings

to dissipate the heat. This arrangement has been used for some time past in quartz lamps. Another method is to use a chamber in which the mercury condenses so as to fall back into the tube in the liquid form (Fig. 4). The conditions of the tube are found to vary somewhat with the temperature of the certain size to the cooling wings or to the condensing cooling of the tube, and for a given voltage used on the lamp a greater current is passed through the lamp. These variations are especially noticed when

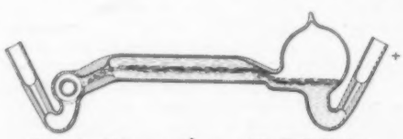


Fig. 4.—Mercury Lamp with Bulb-Cooler

the metal wing cooling is used. In the case of the condensing chamber, the temperature of this latter is always high enough so that the quantity of heat which it dissipates is but slightly affected by any outside changes in temperature. The current in the lamp is adjusted at the required value by giving a certain size to the cooling wings or to the condensing chamber, taking into account also the radiating surface of the tube proper.

The above principles are embodied in a new lamp which has been brought out at Paris and is known as the "Westinghouse-Silica." The quartz tube is mounted with an electro-magnetic device for tilting it, and is surrounded by a large globe, so that it has the general appearance of an arc lamp. The economy of current is almost as great as in the flaming arc, which it will be remembered has 75 per cent economy over the ordinary arc. But this is counterbalanced by the great consumption of carbons and the cost of cleaning of the globe. Briefly stated, the quartz lamp has the following advantages: First, absence of carbons; second, no cleaning of the globe is required; third, better diffusion of light, owing to the fact that the source is of larger volume than an arc; fourth, no trembling of the light from mechanical regulation; fifth, an agreeable white and soft light, without red rays, which is not harmful to the eyes.

Style in Original Scientific Articles

Scientific ability and literary skill do not always keep company in the same individual. The time spent in the acquisition of experimental skill in the laboratory perforce imposes some sacrifice upon the individual in the development of his literary faculties. Moreover, the work of the devotee of science cultivates in him attention to substance rather than to form. He is more concerned with the establishing of facts than with their presentation in "flowing terms." And, indeed, so long as this attitude merely leads to an unembellished, though perfectly clear and sound style, it is entirely beneficial.

Unfortunately, however, the matter does not end there, if we may judge by complaints voiced now and again, criticisms which, it may be mentioned, apply not only to writers in the English language, but to others also. The matter is referred to by Prof. Sedgwick Minot in his vice-presidential address before the American Association, in words which are well worth quoting:

"We are probably all ready to admit that the care bestowed on the presentation in print and picture of original discoveries is often insufficient. Do we not all know articles which are bungled in form and weakened by prolixity? Surely the heads of laboratories should insist by example and precept that all the workers under their influence should write clearly and briefly—for if an author fails to show respect for his own scientific work, how can he expect others to respect it? Yet there are few matters so important as intensifying the world's respect for science. For us, whose language is English, the standard should be highest. Rivarol in his famous prize essay said, 'Ce qui n'est pas clair, n'est pas Francais'—but we might say what is not true, is not English. By its wealth of synonyms and its logical construction the English language is preeminently adapted to the exact statement of scientific truth. We should not misuse so fine an instrument, which if well employed is sure to win for Anglo-Saxon science the wide influence it deserves. Good thinking is the blastema of good style, therefore our learning will never appear good if our learned articles are written badly."

An Aerial Ferry

At Rouen, in France, on the River Seine, there is a bridge that is a sort of aerial ferry. In order to avoid interference with shipping at this point, it was determined to place no structure in the stream, or near its surface. Instead of a bridge in any of the ordinary forms, a horizontal flooring, sustained by steel towers and suspension cables, was stretched across the river at an elevation of 167 feet. On this flooring run electrically-driven rollers, from which is suspended, by means of steel ropes, a car that moves at the level of the wharves on the river banks. The car is 36 feet wide and 42 feet long, and is furnished, like a ferryboat, with accommodations for carriages and foot passengers. The ropes that carry the hanging car are interlaced diagonally in such a manner that the support is rigid, and a swinging motion is avoided.

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